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AN ASSESSMENT OF ALTERNATIVE POLICIES FOR DECREASING GOVERNMENT EXPENDITURES ON COMMERCIAL AIR TRAVEL

THESIS

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Captain, USAF

AFIT/GSM/LSY/89S-1

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THESIS

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James R. Barker

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Abstract

This research assesses several possible policies aimed at decreasing government expenditures on commercial air travel from WPAFB. The policies which are evaluated are policies regarding the use of the promotional fares commonly offered by the large commercial air carriers. These promotional fares are generally lower than the fares presently used by government travelers, but there are significant penalties associated with itinerary changes after ticket purchase.

Computer simulation was used to evaluate these policies. A survey of travel records and a questionnaire administered to a random sample of WPAFB travelers were used to gather information regarding key travel characteristics of base personnel. This data was used as input to the simulation model. Total annual cost, including airfares and penalties, was used as a measure of performance, and separate experiments were run for each policy evaluated.

The results point to cost savings for some of the policies and losses for others. Recommendations for management action and further study are presented.

AN ASSESSMENT OF ALTERNATIVE POLICIES FOR DECREASING GOVERNMENT EXPENDITURES ON COMMERCIAL AIR TRAVEL

I. Introduction

General Issue

The United States government spends many millions of dollars annually on air travel for government employees on official business. Airfares for much of this travel are determined through negotiation between the General Services Administration (GSA) and air carriers as part of the Contract Air Service Program (CASP). These airfares reflect discounts from regular coach fares but are often higher than restricted promotional fares that are offered to the general public by the airlines (15:1). Recent changes to CASP contracts allow the government to purchase tickets at promotional fares in lieu of negotiated CASP fares when the promotional fares are lower (5:10). Additionally, Air Force policy was changed in 1988 to make greater use of promotional fares. However, the decision on the use of a promotional fare is presently made jointly by the traveler, applicable Traffic Management Office (TMO), and orders approving authority (8:1). The government has not mandated the use of these promotional fares by travelers who meet

eligibility requirements nor has it given specific direction or guidance to decision authorities regarding the use of promotional fares. There is a potential that these airfares could be used more often then they are being used and that the government could save a substantial amount of money if it managed to increase the use of the promotional fares.

Definitions

For the purpose of this research, several key terms are defined. Promotional fares are defined as any airfares which reflect discounts from standard coach fares and for which eligibility is restricted on the basis of advance purchase, travel days, stay length, or passenger characteristics. Excursion and super-saver fares are a type of promotional fare for which qualification is based on advance purchase and stay length. Lead time is defined as the elapsed time between the purchase of an airline ticket and departure.

Specific Problem

Although government personnel sometimes know their travel requirements several weeks in advance, they generally do not pursue promotional fares that are available to the general public. It is possible that the use of promotional fares every time that a government traveler meets eligibility requirements could result in decreased costs to the government. Determination of the advisability of such

use of promotional fares is the specific issue that was addressed by this research. Additionally, such a policy may only be advantageous for certain groups of promotional fares. This research also investigated how specific groups of fares may be used to achieve net savings on air travel.

Research Questions

Answers to the following research questions were pursued during the course of this research:

1. How often do travelers from WPAFB use promotional fares? How often are these travelers eligible for promotional fares?
2. What mix of fare types would be likely to result in the largest savings to the government?
3. What guidance could be given to help government personnel to decide whether use of a promotional fare is advantageous to the government?

Scope

This research addressed these research questions for government personnel located at Wright Patterson Air Force Base (WPAFB) only. Any extension to other government installations would require further research. Additionally, this research applies only to travel within the United States as inclusion of international travel would have significantly complicated the research and, because of the

rarity of international travel, accounted for a small difference in total costs.

Various schemes have proven to be successful in saving money on air travel. Many of these schemes involve the use of promotional fares in conjunction with the use of alternate airports, accepting longer layovers, and using only portions of round-trip tickets (2:84-85). These schemes were not modeled. None of the policies tested included altering itineraries as a method to reduce costs.

Reduction of total airfares was the objective of this research. Any administrative costs which would arise from implementing a new policy were not addressed. No details regarding procedures for implementing a new policy were discussed or suggested.

Background

Prior to 1978 the United States airline industry was strictly regulated by the Civil Aeronautics Board (CAB). This organization had control over fares, airline mergers, and both entry and exit of airlines from specific routes (10:105). CAB imposed standard fares based on the results of a study known as the Domestic Passenger Fare Investigation (DPFI) which was conducted in 1974. This investigation yielded a standard fare structure based on mileage alone and did not depend on supply and demand or other economic factors. Price competition was only possible through establishment of new classes of service (16:81).

Additionally, CAB's control of entry to important routes was extremely tight. Between 1938 and 1978, CAB turned down over 150 requests and did not grant any long distance routes to new carriers (6:250).

Due to pressure from the business community regarding the lack of efficiency in the airline industry, Congress established a committee to investigate the effect of regulation on prices and services to the consumer in 1974. This committee, headed by Senator Edward Kennedy, decided that reform was needed, and deregulation gained momentum. The Airline Deregulation Act, which mandated a phased reduction of the CAB's authority, was passed in 1978. CAB's authority over fares ended in 1983, and all operations ceased in 1984 (10:105-106).

The Airline Deregulation Act of 1978 has resulted in a variety of changes to the airline industry. Among these changes are a proliferation of discount fares and fare volatility which reacts to the forces of supply and demand. Computers continuously monitor reservations and adjust the availability of fares in an attempt to induce discretionary fliers without reducing the number of business travelers that pay standard coach fares (12:207). The airlines recognize that the business travel market is stable and cannot be increased substantially by lowering fares. Business travelers will travel roughly the same amount despite fluctuations in ticket prices. However, non-

business travelers can be encouraged to take more trips on airlines if lower prices are offered. In economics terms, non-business travelers have a much higher price elasticity of demand for air travel. With this in mind, the airlines offer promotional fares to fill seats that would otherwise go unfilled and use restrictions to keep business travelers from being eligible for these lower fares (15:13). Discount fares usually include restrictions regarding lead time, length of stay, and day of travel. Lead time restrictions of 2, 7, 14, and 21 days are common. Furthermore, many promotional fares require that the traveler stay at his destination at least one Saturday or Sunday. Some promotional fares reflect discounts up to 80 percent savings from full coach fares, but penalties from 10 percent to the total ticket price are assessed for cancellations or changes (12:207-208). On average, fares dropped approximately 35 percent between 1978 and 1984 (6:251).

Other effects of deregulation include an increase in delays and flight cancellations and a decrease in airline profit margins. The latter phenomenon may be partially due to economic forces that are independent of deregulation (1:52-53). Passenger traffic reached an all-time high of 450 million in 1987 (4:75). Additionally, airline efficiency, as measured by the percentage of seats filled, increased. This parameter, known as load factor, increased by over ten percent after deregulation (6:251).

The primary effect of deregulation on government travel is that it has opened the doors for the government to use its position as a major air travel customer to negotiate low rates for traveling government employees. The Contract Air Service Program began in July 1980 for this purpose. GSA and the Military Traffic Management Command (MTMC) annually solicit bids from air carriers and award contracts based on price and service. This program results in savings of 40 to 70 percent of standard coach fares, but these prices are often higher than promotional fares which are available to the general public and offer up to 80 percent discounts (15:15-16). One drawback arising from CASP was that the government entered into binding agreements with the air carriers not to use promotional fares.

> Where contract air service exists, it is mandatory to use the contract carrier as long as seats are available, flight schedules meet the traveler's mission requirements, and no other carrier offers a lower totally unrestricted fare. (15:16)

Research conducted in 1986 was aimed at determining if CASP continued to provide savings to the government despite trends toward lower promotional fares. The results suggested that the savings from CASP outweighed the government's inability to participate in promotional savings (15:66-67). However, recent changes to CASP allow the government to use promotional fares if they are lower than the negotiated CASP fares.

> When a carrier under contract to GSA offers a fare lower than its contract fare, the lower fare should be

> obtained provided the traveler can meet the requirements of the stated fare....Travelers are advised that in a limited number of instances, non-contract carriers may offer restricted or unrestricted coach fares to the general public which are lower than Government contract fares. In such cases the lower fare(s) may be used. (5:10)

Additionally, Air Force Headquarters (HQ USAF) recently made the use of super-saver fares a joint decision between the traveler, the Traffic Management Office (TMO), and the orders issuing/approving authority. Furthermore, HQ USAF encouraged the use of promotional fares and requested TMOs to supply wing public affairs offices with informational articles aimed at increasing the use of promotional fares. As of 10 Jan 1989, the travel office at WPAFB was not offering travelers promotional fares. If a traveler asked for a promotional fare, the traveler would be given the fare and requested to sign a statement which read, "Passenger is aware of all penalties involved with ticket (8:1)." A January 1989 letter from HQ AFLC attempted to rectify this situation by directing travel offices at AFLC installations to offer promotional fares to qualified travelers and to explain the penalties involved with cancellations or changes (8:1).

As a major consumer of air travel, the government stands to gain a great deal by understanding the air travel environment under deregulation so that it may use this knowledge to devise policies and procedures which lead to the best service and lowest prices attainable. Although

changes to CASP have opened the doors for additional savings by allowing the government to use promotional fares when government travelers meet eligibility requirements, no comprehensive policy has been established to inform employees of the situation or to encourage employees to make reservations early enough to take advantage of the lower fares. Furthermore, the decision to use or refuse a promotional fare belongs to the traveler, and ultimately, the orders approving authority. There is no indication that these people are equipped with the information that is necessary to maximize the benefits of promotional fares. The purpose of this research is to determine how much money could be saved by increasing the use of promotional fares and to provide guidance which could be used by travelers and orders approving authorities that would help the government to realize these savings. The methodology for this research is described in the next chapter.

II. Methodology

Explanation of Approach

The basic characteristics of government travel which determine the availability of promotional fares were determined through a survey of historical travel records and a questionnaire administered to a random sample of government travelers at Wright Patterson Air Force Base. Determination of the effects of these characteristics and various policies regarding the use of promotional fares was accomplished via simulation. The system of air travel by WPAFB employees was modeled using the Simulation Language for Alternative Modeling (SLAM). The policies which were tested were those which mandate the use of specifically defined promotional fares. Total air travel costs were collected as a measure of performance of the system.

The Survey of Travel Records

The objective of the travel record survey was to obtain estimates of the proportion of travelers who use round-trip tickets, the proportion who travel to each location, the proportion whose stay exceeds sixty days, and the proportion whose stay includes a Saturday or Sunday. These factors are all determinants of promotional fare eligibility, and historical records are kept which provide accurate accounts of these characteristics for previous travelers. Ticket stubs and travel orders were randomly drawn from folders of

travel records which are chronologically filed in the travel offices in building 262 at WPAFB. These records reflect the tendencies of travelers from WPAFB areas A and C. Area B personnel typically use the building 11 facility. Access to building 11 travel records would have inconvenienced office workers according to the office manager; therefore, the TMO management report for building 11 travel was used as a suitable alternative.

The required sample size, n, for the travel records survey was determined by treating each measurement question as a binomial experiment, using the number of successes to estimate the binomial proportion, and determining the sample size, n, which yields an acceptable confidence limit. The equation for n is given as:

$$n = \left\{t/\arcsin \frac{d}{[p^{1/2}\cos(\arcsin p^{1/2})]}\right\}^2 \qquad (1)$$

where t is the lower cumulative probability corresponding to the desired tolerance to type I error, d is the half-width of the desired confidence interval, and p is the binomial proportion which is furthest from 0.5 and could reasonably be expected to occur (13:61-63).

For example, if we wish to determine the proportion of travelers who travel to Los Angeles, we designate a trip to Los Angeles as a success and all other routes as failures in our binomial experiment. Assuming that no more than 30

percent of travelers go to Los Angeles, designating 0.1 as our tolerance to type I error, and setting the half-width of the confidence interval on the binomial proportion to .03, we find that the required sample size is 631. Therefore, we are 90 percent certain that a sample of 631 trip records will yield an estimate of the proportion of people who travel to Los Angeles that is accurate to within 3 percent.

No single destination was expected to account for more than 30 percent of trip records; and less than 30 percent of travelers were expected to stay for a weekend, stay in excess of 60 days, or to travel one-way. Therefore, a sample size of 631 was considered sufficient to obtain estimates of each required proportion to within 3 percent at least 90 percent of the time. Therefore, 631 trip records was the target sample size for the survey.

Questionnaire Justification

Information regarding lead times and cancellation rates was vital to the completion of this research because total air travel costs depend on both the availability of promotional fares and the extent of penalties due to cancellations. Historical travel records were sufficient for the purpose of determining the distributions of stay lengths and travel days and for estimating the present use of promotional fares. However, such records were inadequate for determining lead times and for projecting cancellation rates because historical records were taken from a

population of trips in which the travelers had little incentive to book as early as possible or to avoid cancellations. Therefore, a questionnaire was necessary to describe these variables.

The Questionnaire

The questionnaire was administered to customers at the Lifeco travel offices in buildings 11 and 262 at WPAFB. Customers were asked to fill out the questionnaire and to return responses in pre-addressed envelopes. The objective of this survey was to answer the following questions:

1. How far ahead do government travelers know their travel requirements in sufficient detail to make airline reservations? The answer to this question was in the form of proportions of the time that travelers know requirements 2, 3, 7, 14, and 21 days prior to departure. This data is one of the determinants of promotional fare eligibility and was used as input to the simulation model.
2. How often would itinerary changes or changes in travel requirements result in ticket cancellations or changes if a policy mandating the use of promotional fares was implemented? An answer to this question was needed because changes and cancellations of airline tickets which are purchased at promotional rates often result in severe penalty charges. This question was answered separately for all lead times which affect eligibility for promotional fares.

3. To what extent are travelers at WPAFB knowledgeable about their ability to use promotional fares? Use of promotional fares in lieu of negotiated CASP fares became possible very recently. Therefore, knowledge of this flexibility may not be widespread. Depending on the answer to this question, there may be a significant amount of money to be saved by mandating their use.

The questionnaire that was used to answer these questions is at Appendix A. For the purpose of determining the correct sample size, this questionnaire was treated as an opinion poll. The opinions are estimates of the proportion of the time that each respondent knows travel requirements with indicated lead times and the proportion of times that cancellations would result given different circumstances. The required sample size was that which approximated the mean opinion on these matters with reasonable accuracy. The following equation was used to determine the sample size required:

$$n = \frac{N(z^2)\ p(1-p)}{(N-1)(d^2) + (z^2)(p)(1-p)} \qquad (2)$$

where n is the sample size, N is the population size, p is the maximum sample factor (.5), d is the desired tolerance, and z is the factor of assurance (12:11-14). Setting d equal to .10 and z to 1.64 (90% confidence level) we see that a sample size of 67 can be used to describe the base population of approximately 20,000 employees. A 90 percent

confidence level was dictated by the Air Force survey approval authorities (7:1).

Analysis of responses was aimed at determining estimators of lead time proportions and cancellation rates. These estimators were used as direct input into the simulation model.

Justification for Simulation

Simulation is an excellent tool to evaluate proposed changes to complex systems if it is impractical to change or disturb the system for the purpose of experimentation (9:1-6). The complexity of the domestic airfare system makes it impossible to analytically determine the effects of policy changes, and changing policy for the sake of determining such effects was impractical. Therefore, simulation was the best alternative available. Furthermore, the feasibility of simulation of the domestic airline system using SLAM and passenger fare inputs from the Official United States Passenger Tariff had been demonstrated (15:65).

Developing the Model

The system to be modeled was the system of commercial air travel of government personnel employed at Wright Patterson AFB. Specifically, all aspects of that system which contribute to the total costs of air travel for WPAFB official business were modeled. These total costs are determined by the number of travelers, the routes and fares

chosen, and the frequency and magnitude of cancellation penalties.

The Official United States Passenger Tariff (OUSPT) includes a list of all commercial passenger fares from the Dayton International Airport, eligibility rules for each fare, and the rules for and magnitudes of cancellation penalties. A review of this publication revealed that some of the routes have in excess of 100 different fares. Determinants of fares are the air carrier, whether the fare is round-trip or one-way, the status of the passenger (age, organizational affiliation, military leave status or family status), the lead time, the travel days, the stay length, and the size of the traveling group. One class of fares, excursion fares, relies solely on lead time, travel day, and stay length for qualification.

In the interest of developing a parsimonious model, fares were eliminated if qualification by government travelers on official business was highly unlikely. Examining the status fares, we see that we can eliminate the fares for children, senior citizens, military members on leave, family members traveling together, full-time students, and airline employees. This leaves us with only one type of passenger <u>status</u> fare which is relevant -- the fares for federal employees traveling on official business. Group fares were similarly eliminated, and fares which require travel within several days of Thanksgiving or

Christmas were eliminated. This elimination process leaves us with the following types of fares: normal one-way and round-trip fares, excursion fares, and status fares for federal employees on official business.

Further review of OUSPT revealed that the remaining airfare types follow a general ordinal pattern of cost. For one-way fares, the government status fares were lower than the normal fares. For round-trip travel, excursion fares were generally lowest with the lowest excursion fares requiring the longest lead times. The next lowest fare for round-trip travel was a combination of two government one-way fares. Normal round-trip fares were the next most economical, followed by combining two normal one way fares. (First class fares were the most expensive, but they are rarely used for official government travel and were excluded from the model.) This general relationship was used as the basic logic for assigning the lowest applicable airfare in the model.

Eligibility for excursion fares requires the passenger to stay either one Saturday or Sunday, to stay no more than 60 days, to travel round-trip, and to have a lead time of at least 2, 3, 7, 14 or 21 days. Therefore, a model which tests each of these conditions can assign the low excursion fares as appropriate. A flow chart for such a model is at Figure 1.

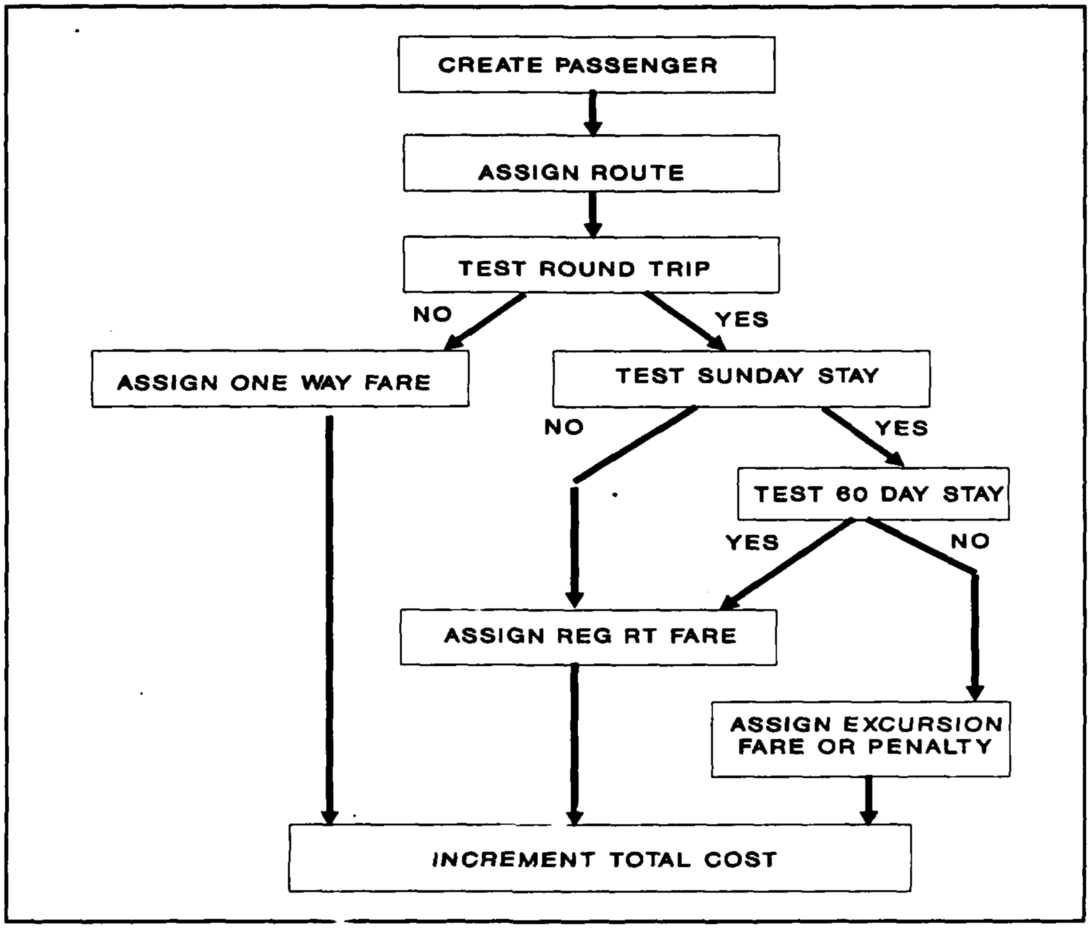

Figure 1. Flow Chart

The estimated number of travelers from WPAFB for a year (approximately 74,000) are created, and their travel routes are assigned in accordance with estimates of the proportions inferred from historical travel records. Next, a test for round-trip travel is conducted which is also based on historical travel record proportions. If the test fails the passenger is assigned the lowest one-way fare for that route. This is a government status fare if one exists or a normal one way fare if no government fare exists. If the round-trip test passes, tests are conducted for a Saturday

or Sunday stay and for a stay length of less than 60 days. If one of these tests fails, the passenger is assigned the normal round-trip or status fares. If both tests pass, a test of lead time is conducted to assign the excursion fare for which the passenger is eligible. This test is based on the lead time distribution inferred from the questionnaire.

In addition to the assignment of fares, the appropriate cancellation or change fee is assigned to each passenger. Each passenger is then tested for a trip change or cancellation. If a cancellation is not generated, then the assigned fare is added to a running total of airfare costs and the passenger entity is terminated. If a change or cancellation is generated, then the appropriate penalty is assessed, and the passenger sent back for assignment of a new route if necessary. Reassignment for cancelled trips is accomplished in recognition of the fact that a cancellation fee tends to increase total costs in the real system. Therefore, it is important that the same number of travelers complete travel in each simulation to avoid the illusion that a small cancellation penalty is more cost effective than an actual fare.

Coding the Model

The model was coded in the Simulation Language for Alternative Modeling II, version 4.0 (SLAM) for a variety of reasons. First, the feasibility of using SLAM had been demonstrated by Shepherd (15:65). Additionally, SLAM is taught at the Air Force Institute of Technology and both the researcher and faculty advisor are familiar with SLAM. Also, SLAM is available on an AFIT mainframe, is easy to document, and has convenient statistics capabilities.

A primary objective of the coding phase of this project was to develop a common routine which could be used for all routes being simulated. This was not done in Shepherd's study and the result was 1200 lines of code which modeled a total of 10 routes (15:70-105). Given that many more routes were to be modeled for this research, a common routine for all routes was considered necessary to limit the potential for error and to allow coding to be completed during the allotted time. Use of a common routine for all routes necessitated the use of SLAM's look-up table capability. Relevant fares and penalties for each route were entered into a table and extracted as necessary during the simulation. SLAM array statements were used for this purpose. A separate array statement was used for each route modeled, and relevant one-way fares, round-trip fares, excursion fares, and penalties were entered into the array. Using one array statement for each route, a rectangular

array of the number of routes modeled times the number of fares and penalties per route was created.

The relevant fares and penalties were compiled using OUSPT as a source document. The commonly traveled routes were looked-up in OUSPT section A, the alphabetical route listing, and a search was conducted for relevant status fares. These fares are characterized by a three letter class code ending in the letters "CA" or "DG". YCA fares are unrestricted contract fares. Other fares ending in CA are lower government contract fares which are restricted on the basis of travel times or capacity. Fares ending with "DG" are discounts offered to government travelers which are not contract fares (5:4). If such fares were located, they were recorded. If no applicable status fares were located, the normal one-way fares (Y class) were recorded instead. One-way fares which were recorded were then multiplied by two to yield the corresponding round-trip fares. Next, a search for excursion fares was conducted. This search revealed that the longest lead time requirement for relevant routes was 14 days. The class codes for these fares typically end with "14X" or "14NR". When such a fare was located, the applicable four-digit rule code was noted and eligibility rules and associated penalties were investigated with the aid of OUSPT section B. This process revealed a trend that 14 day excursion fares result in total forfeiture of purchase price upon cancellation.

Next, 7 day excursion fares were investigated in a similar manner. These fares fall into two categories. The first category is those fares which are associated with total price forfeiture for cancellation but just a flat $75 fee for changes. These fares typically end with "7OX". The second category of 7 day excursion fares is those which result in a 25 percent penalty for either cancellations or changes. The typical suffixes for these fares are "7OP25" and "7P25". Finally, the two day excursion fares and penalties were investigated. These fares tended to have a 25 percent penalty regardless of whether a traveler cancelled or changed flights. These fares typically end with a "2P25" suffix. Many fares included "WE", "HOL", "HHE", or "HLE" in their class codes. Investigation of these fares in OUSPT section B revealed that these fares were restricted to weekend or holiday travel. These fares were eliminated in favor of the "XE" fares which apply to normal weekday travel. All fares which were used in the simulation are tabulated in Appendix B.

This review of available airfares resulted in an important observation. For many routes there were several different fares which involve the same eligibility criteria and penalties. Further investigation showed that some of these differences were attributable to the fact that different carriers were involved. Other differences were attributable to the industry practice of offering capacity-

controlled fares. With this practice there are several prices available. The lowest prices are in short supply and available on a first-come, first-served basis. Information regarding the frequency with which all types of capacity-controlled fares are used is unavailable, and investigation of these frequencies is outside of the scope of this research. In lieu of such an analysis, simple averages of available fares were used as an approximate amount spent per trip. These averages were calculated and tabulated in Appendix B. The average fares and penalties were entered into the beginning of the model in the form of ARRAY statements. A sample of these array statements follows:

```
    ;      OW   RT F14 F7X CH7 F7  CC7 F2  CC2
ARRAY(1,9)/140,280,208,198, 75,248, 62,217,  0; DCA
ARRAY(2,9)/169,338,301,248, 75,378, 96,388, 97; LAX
ARRAY(3,9)/186,371,258,248, 75,308, 77,371,  0; SAT
    .
    .
    .

ARRAY(49,9)/173,357,165,148, 75,202, 51,347,  0; DTW
```

The values in these statements are either taken directly from OUSPT or are averages tabulated in Appendix B. The first column after the slashes holds the lowest one-way fare available to government travelers (or an average of several available fares). The second column holds average round-trip fares used by government travelers. The third column is the average of 14 day excursion fares. Since cancellation of a 14 day excursion fare results in total

forfeiture of the fare, there is no need for a separate column for cancellation penalties. The fourth column is for seven day excursion fares which have specific penalties for changes, and the fifth column holds those penalties. The sixth column is the 7 day excursion fares for which their is a 25 percent charge for cancellations or changes, and the seventh column is the 25 percent penalties. The eighth column is for 2 day excursion fares, and the ninth column is the associated change and cancellation fee. When a route does not have any of one type of excursion fare, the applicable fare column is filled with the regular round-trip fare, and the corresponding penalty column is filled with a zero. The three-letter codes following the semicolons are comments which indicate the destination airports.

The next part of the model's code is comment cards which define the attributes which were used to describe each passenger entity and the global variables which were tracked during the simulation. Attribute 1 is defined as the route that the passenger uses. The number stored in attribute 1 corresponds with the number of the array statement which contains information on that route. Attributes 6,7, and 8 are defined as the change penalty, fare, and cancellation penalty assigned to a passenger, respectively. Global variable XX(1) is defined as the sum of the costs that are incurred as all passengers move through a one year simulation. Global variable XX(2) is used to keep track of

the number of passengers which have been simulated up to a given point in a single run. This variable was used near the end of the simulation to trigger collection of statistics when the final passenger in a run was simulated. Global variable XX(3) is defined as the average cost incurred per simulated passenger during a run. This parameter was useful for comparison between runs and for comparison to real data that were used in validating the model.

The next block of code creates simulated passengers, assigns fares and penalties, and collects relevant statistics for the simulation. The first two lines of this block are dedicated to the creation of passengers and incrementing the passenger counter, variable XX(1), to keep track of the latest passenger created:

```
NETWORK;
        CREATE,1,,,74000,1;
        ASSIGN,XX(2)=XX(2)+1;
```

This code creates one passenger during each simulation time unit until 74,000 passengers, the number traveling from WPAFB in a year, are created.

At this point, the network must assign each passenger a route. A SLAM go-on (goon) node is used in combination with separate activity statements for each possible route. The goon statement includes a "1" to indicate that each passenger entity is only allowed to pass to one of the

subsequent activity statements, thus insuring that each simulated passenger travels just one route. The activity statements include a number which is indicative of the proportion of all travelers who use a particular route and a flag which points to a separate route assignment routine for each route. The sum of all of the proportions for the activity statements is equal to one -- guaranteeing that each passenger is assigned to a route. Once a passenger is sent to a route assignment routine, an assign statement is used to set the passenger's atrib(1) equal to the numerical code for that route. Next, an activity statement is used to send the passenger to the round-trip test (RTT) routine.

```
      GOON,1;
      ACTIVITY,,0.1507,DCA;
     .
     .
DCA  ASSIGN,ATRIB(1)=1;
     ACTIVITY,,,RTT;
```

In this example, slightly over 15% of passengers are assigned to the Dayton - Washington DC route. (DCA is the airline code for Washington National Airport.)

The test for round-trip travel is accomplished with a goon node and two activity statements. This goon node also allows passage to only one of the subsequent activity statements. The first activity statement is used for each passenger that flies round-trip, and the second activity statement used only by one-way travelers:

```
RTT   GOON,1;
      ACTIVITY/1,,0.954,SUNT;
      ACTIVITY/2,,0.046,ASF1
```

In this example, over 95 percent of passengers fly round-trip and are subsequently sent to the Sunday stay test (SUNT). Less than 5 percent fly one-way and are sent to a routine which assigns the appropriate one-way fare (ASF1).

The routine which assigns one-way fares consists of an assign statement, which increments the total cost for the run by the appropriate one-way fare, and an activity statement which sends the passenger to the termination routine (TERM):

```
ASF1  ASSIGN,XX(1)=XX(1)+ARRAY(ATRIB(1),1);
      ACTIVITY,,,TERM;
```

The variable XX(1) holds the sum of the costs for the run and is incremented by the first value which is stored in the appropriate array statement. This value is the average one-way fare for this route.

The Sunday stay test is coded as follows:

```
SUNT   GOON,1;
       ACTIVITY/3,,0.179,SIXT;
       ACTIVITY/4,,0.821,ASF2;
```

Nearly 18 percent of passengers are flagged as staying at their destination at least one Sunday. These passengers are sent to the 60 day stay test (SIXT). Over 82 percent of the passengers do not stay at their destinations for at least

one Sunday, are not eligible for excursion fares, and are sent to the routine which assigns normal round-trip fares (ASF2).

The normal round-trip fare assignment routine is coded exactly as the one-way routine with the exception that the second value in the array statement is the one that is used to increment total costs, XX(1):

```
ASF2   ASSIGN,XX(1)=XX(1)+ARRAY(ATRIB(1),2);
       ACTIVITY,,,TERM;
```

The 60 day stay test is coded similarly to the round-trip test routine:

```
SIXT   GOON,1;
       ACTIVITY/5,,0.997,LTT;
       ACTIVITY/6,,0.003,ASF2;
```

Nearly 100 percent of passengers stay at their destination for less than 60 days and are eligible for excursion fare consideration. These passengers are sent to the lead time test routine (LTT). The small fraction of passengers who stay in excess of 60 days are ineligible for excursion fares and are sent to the normal round-trip fare assignment routine (ASF2).

The lead time test routine tests for lead times in excess of 14 days, between 7 and 14 days, between 2 and 7 days, and between 0 and 2 days:

```
LTT   GOON,1;
      ACTIVITY/8,,0.2377,ASF4;
```

```
ACTIVITY/9,,0.2604,ASF5;
ACTIVITY/11,,0.3971,ASF7;
ACTIVITY/12,,0.1048,ASF2;
```

Nearly 24 percent of passengers have lead times in excess of 14 days and are sent to the 14 day excursion fare routine (ASF4). Likewise, 26 and 39.7 percent are sent to the 7 and 2 day excursion fare routines (ASF5 and ASF7). Slightly over ten percent have lead times of less than 2 days. These passengers are ineligible for excursion fares and are sent to the normal round-trip fare routine (ASF2).

The 14 day excursion fare routine is coded as follows:

```
ASF4    ASSIGN,ATRIB(7)=ARRAY(ATRIB(1),3),1;
        ASSIGN,ATRIB(8)=ARRAY(ATRIB(1),3),1;
        GOON,1;
        ACTIVITY/13,,0.557,ASC;
        ACTIVITY/14,,0.443,;
        ASSIGN,XX(1)=XX(1)+ATRIB(7);
        ACTIVITY,,,TERM;
```

The fare and cancellation attributes (ATRIB(7) and ATRIB(8)) are both assigned the values in the third column of the array since cancellation results in total forfeiture of purchase price with this type of fare. Next, goon and activity statements are used to test for cancellation. Here, 55.7 percent are sent to the cancellation routine, and 44.3 percent are not cancelled. For these travellers, total costs, XX(1), are incremented by the 14 day excursion fare.

The seven day excursion fare routine is slightly more complex as there are change fees associated with these fares that are different from the cancellation fees. This routine is coded as follows:

```
ASF5  ASSIGN,ATRIB(7)=ARRAY(ATRIB(1),4),1;
      ASSIGN,ATRIB(8)=ARRAY(ATRIB(1),4),1;
      ASSIGN,ATRIB(6)=ARRAY(ATRIB(1),5),1;
      GOON,1;
      ACTIVITY/15,,0.117,ASC;
      ACTIVITY/16,,0.560,NOCH;
      ACTIVITY/17,,0.323,;
      ASSIGN,XX(1)=XX(1)+ATRIB(6);
NOCH  ASSIGN,XX(1)=XX(1)+ATRIB(7);
      ACTIVITY,,,TERM;
```

Fares and cancellation fees are taken from the fourth column of the array, and change fees, ATRIB(6), are taken from the fifth column. A goon node and three activity statements are used to determine which passengers cancel, which passengers complete their travel without change, and which passengers change one of their flights. In the above example, 11.7 percent cancel, 56 percent complete their travel without changes, and 32.3 percent change a flight. These 32.3 percent have both the fare and a change penalty added to total costs, XX(1).

The two day excursion fare routine is coded as follows:

```
ASF7  ASSIGN,ATRIB(7)=ARRAY(ATRIB(1),8),1;
```

```
        ASSIGN,ATRIB(8)=ARRAY(ATRIB(1),9),1;
        GOON,1;
        ACTIVITY/18,,0.218,ASC;
        ACTIVITY/19,,0.782,;
        ASSIGN,XX(1)=XX(1)+ATRIB(7)
        ACTIVITY,,,TERM;
```

This is identical to the coding for the 14 day excursion fare except that the fares and cancellation fees are drawn from two separate columns in the array (ATRIB(8) and ATRIB(9)).

The routine for assigning cancellation fees is simply coded as an assign node to increment XX(1) by the amount of the fee and an activity statement to reassign the passenger to a different route. (This guarantees that the same number of passengers complete travel in every one year simulation.)

```
ASC     ASSIGN,XX(1)=XX(1)+ATRIB(8);
        ACTIVITY,,,RTT;
```

The next routine in the network is the routine that terminates each passenger and collects the appropriate statistics.

```
TERM    GOON,1;
        ACTIVITY,,XX(2).LT.74000,NEXT;
        ACTIVITY,,XX(2).GE.74000;
        ASSIGN,XX(3)=XX(1)/74000;
        COLCT(1),XX(1),TOT COST,20/26640000/37000;
        COLCT(2),XX(3),AVG FARE,;
```

```
NEXT  TERMINATE;
      END NETWORK;
```

This routine first uses goon and activity statements to determine which passenger is being simulated. If the passenger is the last one of the simulation, statistics for average and total costs are collected and the run is ended. If the passenger being simulated is not the last one, the passenger is terminated and a new passenger is created.

The result of this coding phase is a concise and powerful model. The model is approximately 300 lines long, yet it addresses travel to 48 airports with 6 fares per airport. The entire model, complete with comment cards and appropriate SLAM control statements is at Appendix C.

Meeting the Research Objectives

Answers to the research questions were pursued as follows:

1. How often do travelers from WPAFB use promotional fares? How often are these passengers eligible for promotional fares?

The extent of the present usage of promotional fares was calculated as a simple percentage from the travel records survey. The extent of possible usage was calculated from questionnaire responses by using the percentages who have applicable lead times and stay lengths.

2. What mix of fare types would be likely to result in the largest savings to the government?

In order to answer this question, the different types of excursion fares were segregated according to lead time requirements and penalties. A preliminary screening experiment was conducted to determine which fare types lead to net savings and which generate penalties which are greater than their savings. Those fares that resulted in net savings were then used in a separate experiment to determine what mix of fares would generate the greatest net savings.

Seventy-four thousand trips constituted a run, and total costs were collected for each run. Twenty runs were accomplished for each scenario and results were compared to the results from runs in which promotional fares were not used (control scenario). Outputs of the performance measure (total costs) were treated as if they were outputs from the real system for the purpose of statistical analysis (14:724). An analysis of variance (ANOVA) and a Scheffe multiple comparison test were conducted to determine if there were significant differences between fare mix policies.

3. What guidance could be given to those deciding on the use of promotional fares which would be likely to reduce costs?

The results and analysis of the experiments described above were used to formulate rules-of-thumb regarding the advisability of using each of the major types of excursion

fares. These rules were tempered in light of the limitations of this research, and guidelines regarding deviation from these rules were defined.

III. Analysis of Results

Introduction

Analysis of results was accomplished in four distinct areas. The first area was the analysis of the results obtained during the survey of travel records. The second area was the analysis of responses obtained from the questionnaire. The objective of these first steps was to obtain average values of important parameters which could be entered into the model. The third area of analysis involved model validation. The model was run to simulate the present method of assigning airfares. Results obtained from this simulation were then compared to actual values obtained during the travel record survey. Finally, experiments described in chapter two were conducted to determine the effects of various alternative methods of assigning airfares. The results of these experiments were then analyzed to determine if statistically significant differences exist.

Analysis of Travel Record Data

The travel record survey involved the extraction of data from 795 records. Of these, 445 were building 11 records which were included in the TMO management report. The remaining 350 were detailed records which included actual ticket stubs of customers who use the building 262 travel office. These travel records included data regarding

the routes traveled, whether the travel was round-trip or one-way, and the dates of travel. From these dates, the portions of travelers who had a Sunday stay and whose stay exceeded sixty days were derived. The records from the management report regarding building 11 customers included data on the fare used, the route, and whether travel was round-trip or one-way. No travel dates were included in this report.

Determination of the frequency to which each destination city was traveled was accomplished by combining data from the management report and the travel records in approximately the same proportion that customers use the building 11 and building 262 facilities. All 445 building 11 records were used while only 186 of the building 262 records were used. This combined approach was done in recognition of the fact that customers of the two facilities represent different organizations and tend to travel to different cities. By combining the two sets of data, the overall travel habits of the base population were approximated. Tabulating the number of passengers which travel to the top 48 cities, we see that 617 of the 631 passengers travel to these cities. Each of these cities was represented at least twice. The other 14 passengers traveled to cities that were represented only once in this sample. By eliminating these 14 cities, 98 percent of the travel was captured, and only 77 percent of the cities were

modeled. Calculation of the proportion who travel to each of the top 48 cities was accomplished and the results displayed in Table I.

The 350 records from building 262 were the only ones which include data regarding travel dates. Therefore, they were used as the sole basis for determining how often passengers stay over at their destination for a Sunday and how often their stay exceeded 60 days. These 350 records included 312 round-trips, 29 one-way trips, and 9 circle trips. (A circle trip is one in which the passenger returns to the same location that he began the trip but stays at 2 or more destinations during the trip.) These trips were discarded as they cannot benefit from excursion fares and are, therefore, not modeled. Using Eq (1), we find that this reduced sample size changed the half-width of the 90 percent confidence interval to .04 for binomial proportions near .15. Thus, we are 90 percent sure that binomial proportions such as travel to Washington National Airport are accurate to within 0.04. For binomial proportions close to .01, such as travel to Phoenix, the half-width of the 90 percent confidence interval is approximately .009.

Reducing the survey data to the relevant proportions, we have:

$$312/341 = 0.915 \text{ round-trips} \tag{3}$$

$$29/341 = 0.085 \text{ one-way trips} \tag{4}$$

Table I: Portions of Travel by Destination

AIRPORT	CODE	TRAVELERS	PORTION OF TOTAL
WASH NAT	DCA	93.0000	0.1507
LOS ANGELES	LAX	80.0000	0.1297
SAN ANTONIO	SAT	48.0000	0.0778
DALLAS	DFW	42.0000	0.0681
ST LOUIS	STL	28.0000	0.0454
SALT LAKE	SLC	27.0000	0.0438
SEATTLE	SEA	18.0000	0.0292
FORT WALTON	VPS	17.0000	0.0276
SAN DIEGO	SAN	17.0000	0.0276
DENVER	DEN	14.0000	0.0227
ATLANTA	ATL	13.0000	0.0211
OK CITY	OKC	13.0000	0.0211
SACRAMENTO	SMF	12.0000	0.0194
SAN FRANCISCO	SFO	12.0000	0.0194
ORLANDO	MCO	10.0000	0.0162
PALM BEACH	PBI	10.0000	0.0162
ONTARIO CA	ONT	9.0000	0.0146
LAGUARDIA	LGA	8.0000	0.0130
SYRACUSE	SYR	8.0000	0.0130
ALBUQUERQUE	ABQ	8.0000	0.0130
HARTFORD	BDL	8.0000	0.0130
OHARE	ORD	7.0000	0.0113
PHOENIX	PHX	7.0000	0.0113
WICHITA	ICT	7.0000	0.0113
TAMPA	TPA	7.0000	0.0113
BOSTON	BOS	7.0000	0.0113
BALTIMORE	BWI	6.0000	0.0097
HUNTSVILLE	HSV	6.0000	0.0097
LONG BEACH	LGB	6.0000	0.0097
NEWARK	EWR	5.0000	0.0081
OMAHA	OMA	5.0000	0.0081
PHILADELPHIA	PHL	5.0000	0.0081
LAS VEGAS	LAS	5.0000	0.0081
MACON	MCN	4.0000	0.0065
MONTGOMERY	MGM	4.0000	0.0065
MINNEAPOLIS	MSP	4.0000	0.0065
TUCSON	TUS	4.0000	0.0065
DULLES	IAD	4.0000	0.0065
NEWPORT NEWS	PHF	4.0000	0.0065
COL SPRINGS	COS	4.0000	0.0065
SAN JOSE	SJC	4.0000	0.0065
PITTSBURGH	PIT	3.0000	0.0049
KENNEDY	JFK	3.0000	0.0049
ROANOKE	ROA	3.0000	0.0049
ORANGE CO	SNA	2.0000	0.0032
CHARLOTTE	CLT	2.0000	0.0032
BUFFALO	BUF	2.0000	0.0032
DETROIT	DTW	2.0000	0.0031
TOTALS		617.0000	1.000

Additionally, these records included 56 weekend stays, one stay that was in excess of 60 days, and 4 excursion fares. This data reduces as follows:

$$56/341 = 0.164 \text{ weekend stays} \tag{5}$$

$$1/341 = 0.003 \text{ 60 day stays} \tag{6}$$

$$4/341 = 0.012 \text{ excursion fares} \tag{7}$$

The stay length and round-trip proportions were input directly into the model.

Analysis of Questionnaire Responses

A total of 79 responses to the questionnaire were received. These responses were evaluated to determine the extent of knowledge that WPAFB travelers have about the use of excursion fares, the distribution of lead times that are experienced, and the likelihood of cancellation and change penalties if more excursion fares were used. The raw survey data is at Appendix D, and the mean questionnaire responses are in Table II.

Part 1 of the questionnaire was designed to determine the extent of knowledge that the base population has regarding the use of contract fares and excursion fares. This part of the questionnaire consisted of seven questions. The first question simply asked which organization the respondent represented, and the second question asked how many trips the respondent took per year.

Table II: Mean Questionnaire Responses

Question	Mean Response (percent)
1.a	10.47
b	11.67
c	27.85
d	26.04
e	12.29
f	11.48
2.a	30.58
b	34.89
c	23.07
3.a	23.30
b	29.44
c	18.15
4.a	13.43
b	18.96
c	11.68
5.a	8.90
b	14.08
c	7.29
6.a	6.08
b	11.47
c	5.96

The third question asked if the respondent knew that negotiated fares were used for most official government travel. An overwhelming majority, 94.9 percent, responded that they did know this to be the case. The fourth question asked if the respondents knew that promotional fares were often available which were lower than the contract fares. A majority, 70.9 percent, responded that they knew that these lower fares were available. When asked if they knew that it was possible for government travelers to use these lower fares, only 36.7 percent answered in the affirmative; and, when asked if they had ever used a promotional fare for government business, only 19 percent responded "yes".

Part 2 of the questionnaire was designed to determine the distribution of lead times that base travelers experience and the frequency with which they would experience cancellation and change penalties if the use of promotional fares was increased.

Question 1 was used to determine the distribution of lead times. At the time the questionnaire was prepared, it was not known that the 3 and 21 day excursion fares were irrelevant for the routes simulated. Therefore some of the survey responses had to be combined to estimate necessary parameters. The average value for the 0 to 2 day lead time was calculated directly. The value for the 3 to 7 day lead time was obtained by adding the 2 to 3 day and 3 to 7 day values. The value for the 7 to 14 day lead time was calculated directly, and the value for the greater than 14 day lead time was obtained by adding the value for 14 to 21 to the value for greater than 21. The results are recorded in Table III.

Table III: Mean Lead Time Distribution

Lead Time	Percent
0-2	10.47
3-7	39.51
7-14	26.04
14+	23.8

These values, when summed, total 100 percent and were used in the lead time subroutine of the model.

Questions 2 through 6 were designed to determine the frequencies of cancellation and change penalties given that

each type of promotional fares was used each time that a traveler qualified. The answers to question 2 became irrelevant when the fare search described above revealed that no 21 day excursion fares were included in the relevant routes. Likewise, the answers to question 5 became irrelevant. The answers to question 3 were used for the 14 day excursion fare routine. Since cancellations or changes result in total fare forfeiture, only 2 parameters are needed: the proportion who complete travel without changes, and the proportion who change or cancel. Assuming independence of events, the probability of completing travel without change or cancellation is given by:

$$Pnc = (1-Po)(1-Pr)(1-Pc) \tag{4}$$

where Po is the probability of changing the outbound flight, Pr is the probability of changing the return flight, and Pc is the probability of cancelling a flight. Substituting the answers for questions 3 a, b and c into this equation, we get Pc = 0.443. This result is used in the 14 day excursion fare routine.

The important parameters for the 7 day excursion fare routine are calculated differently. The probability of a cancellation is taken directly, and the probability of a change is calculated by adding the probabilities reported for both outbound and return changes.

Pcancel = .117

Pchange = .323

Pnc = .56

These parameters were entered into the 7 day excursion fare routine.

The answers to question 6 were used to derive important parameters for the 2 day excursion fare routine. The probability of no change was derived using Eq (4), and the probability of a penalty was the remaining portion:

Pnc= .782

Ppenalty =.218

These parameters were entered into the 2 day excursion fare routine.

Validation of the Model

Validation of the model consisted of several distinct steps. First, the model was set to simulate the present state of affairs in fare assignment. In order to do this, a minor change to the model code was accomplished. Presently, WPAFB travelers demonstrate negligible use of promotional fares. The simplest approach to simulating this state was to change the Sunday stay test such that none of the travelers stay for a Sunday:

```
SUNT  GOON,1;
      ACTIVITY/3,,0,SIXT;
      ACTIVITY/4,,1,ASF2;
```

The net effect is that none of the simulated passengers were eligible for promotional fares, and all assigned fares were normal or status fares. The result of this simulation was

an average ticket price of $365.5. The survey of travel records yielded an average ticket price of $363.7. This small difference could be explained by a combination of random variation and the fact that average fares were used. Although this comparison does not prove that the model is working correctly, the values are considered close enough that they do not constitute evidence that the model is not working correctly.

The other aspect of validation involved predicting the models reaction to changes in the code, making those changes, and comparing output to the predictions. Some of this work was done incrementally during development of the model. The model was coded in small increments and run at various stages through its development. Output generally behaved as expected, and any unusual behavior was immediately noticed and corrected. In addition, a variety of experiments were run to insure that the complete model behaved as predicted. Table IV depicts the parameters that were varied, the direction they were varied, the predicted effect on average ticket price, and the observed effect on average ticket price.

Table IV: Summary of Validation Experiments

Parameter	Change	Predicted Move	Observed Move
Lead Time	+	-	-
Lead Time	-	+	+
Cancel Rate	+	+	+
Cancel Rate	-	-	-
Fares	+	+	+
Fares	-	-	-

In all cases, the average ticket price moved in the direction that was expected. Again, there was no evidence that the model was not working correctly.

Evaluation of Alternative Fare Usage Strategies

Following evaluation of the existing situation and determination of travel profiles, additional experiments were conducted to evaluate alternative fare usage strategies. As shown above, a number of travelers could use discount fares which might result in savings to the government. Two experiments were conducted to identify and evaluate usage strategies. A preliminary experiment was conducted to determine which, if any, fare types would contribute to savings. A second experiment was conducted to identify the mix of fare types which would be likely to generate the greatest achievable savings.

Preliminary Experiment

The first experiment was conducted to determine which fare types would contribute to savings. This process allows us to screen out those fare types which generate greater penalties than savings and to exclude such fares from the mixed fare experiment which followed. This preliminary experiment consisted of simulating five environments and comparing the results to the results obtained from simulation of the current situation. The first environment which was simulated was that in which all passengers who were eligible for excursion fares obtained them. In the cases where a passenger was eligible for more than one promotional fare, the passenger would always opt for the lowest fare regardless of the change and cancellation penalties involved. The other four environments involved selected use of only one of the following four fare types:

14 day non-refundable excursion fares

7 day non-refundable excursion fares

7 day excursion fares with 25 percent penalties

2 day excursion fares with 25 percent penalties

These fares were used at rates consistent with the maximum discount environment but were simulated on a one-at-a-time basis while using normal or status fares for all other travel. This procedure allowed the effects of each of these fare types to be separated. Twenty runs of each environment were completed.

Simulation of the maximum discount environment was straightforward. The logic of the model was such that travelers who qualified for excursion fares were assigned those fares based on their lead times. Those passengers who had long lead times were assigned the 14 day excursion fares, and those with shorter lead times were assigned the other excursion fares. Since the deepest discounts are associated with the longest lead times, no changes to the models logic or parameter values were necessary to simulate the maximum discount environment.

The second environment simulated examined the maximum use of 14 day non-refundable excursion fares. In order to simulate this situation, a change to the lead time test (LTT) routine was made. The proportion of travelers with lead times greater than 14 days was unchanged, but the proportion with lead times between 2 and 7 days and between 7 and 14 days were set to 0. Thus, any passengers who did not qualify for 14 day excursion fares were assigned normal round-trip fares from the second column of ARRAY. The new LTT was as follows:

```
LTT   GOON,1;
      ACTIVITY/8,,0.2377,ASF4;
      ACTIVITY/9,,0,ASF5;
      ACTIVITY/11,,0,ASF7;
      ACTIVITY/12,,0.7623,ASF2;
```

The third environment that was simulated examined the maximum use of 7 day non-refundable excursion fares. The change to the coding was similar to the change for the 14 day fares in that all lead time proportions except for the 7 day lead time were set to 0.

```
LTT   GOON,1;
      ACTIVITY/8,,0,ASF4;
      ACTIVITY/9,,0.2604,ASF5;
      ACTIVITY/11,,0,ASF7;
      ACTIVITY/12,,0.7396,ASF2;
```

The fourth environment simulated examined the maximum use of 7 day excursion fares with 25 percent changes for cancellation or change fees. The change to the code for this experiment involved the use of columns 6 and 7 in array for the assignment of fares and penalties (columns 4 and 5 had previously been used.)

```
ASF5  ASSIGN,ATRIB(7)=ARRAY(ATRIB(1),6),
      ASSIGN,ATRIB(8)=ARRAY(ATRIB(1),7),1;
      ASSIGN,ATRIB(6)=ARRAY(ATRIB(1),7),1;
      GOON,1;
      ACTIVITY,,0.117,ASC;
      ACTIVITY,,0.560,NOCH;
      ACTIVITY,,0.323,;
      ASSIGN,XX(1)=XX(1)+ATRIB(6);
NOCH  ASSIGN,XX(1)=XX(1)+ATRIB(7);
      ACTIVITY,,,TERM;
```

The fifth environment was simulated to evaluate the maximum use of 2 day excursion fares with 25 percent cancellation/change penalties. Once again, this was accomplished by modifying the proportions in the lead time test routine:

```
LTT   GOON,1;
      ACTIVITY/8,,0,ASF4;
      ACTIVITY/9,,0,ASF5;
      ACTIVITY/11,,0.3971,ASF7;
      ACTIVITY/12,,0.6029,ASF2;
```

Results of the first experiment, simulating five environments and the control environment, are presented in Table V.

Table V: Summary of Preliminary Experiment

Environment	Fare(s) Used	Total Cost($M)	Standard Dev($)
control	regular	27.05	30,000
1.	max discount	27.09	26,541
2	14NR	27.31	23,480
3	7NR	26.85	24,930
4	7P25	26.95	25,770
5	2P25	27.01	29,660

A review of these results shows that penalties outweigh savings for maximum discount environment and the 14 day excursion fare environment. However, the use of the other three categories of excursion fares would generate more cost

savings than penalties. Additionally, the use of 7 day non-refundable excursion fares results in lower total costs than the use of 7 day excursion fares with 25 percent cancellation fees. Two sample "t" tests were used to compare the mean total costs for each of the five environments to the control or current environment. Designating the tolerance to type I error, alpha, as .05 and making the null hypothesis equivalence of the mean annual total cost, we find that all five differences between means are statistically significant.

Experiment Regarding Mixed Fare Usage

A second experiment was conducted based on the results of the preliminary experiment. Those fare types which were determined to generate cost savings were combined in several ways to determine which mix would generate the greatest net savings.

Review of the results of the preliminary experiment reveals that elimination of the 14 day excursion fares and use of 7 day non-refundable fares instead of 7 day fares with 25 percent penalties would yield greater savings. However, a question remains concerning whether greater savings would be achieved by maximizing use of two day excursion fares or by maximizing use of 7 day non-refundable fares. The preliminary experiment did not take into account that a traveler who had a long lead time could use any of the fares with shorter lead times. For instance, any

traveler who qualified for a seven day excursion fare would qualify for a two day excursion fare. (He would simply wait to buy his ticket to take advantage of the lower reported cancellation and change rates associated with a 2 day advanced purchase). Therefore, the 2 day, 7 day, and 14 day lead time proportions could be added together and applied to 2 day excursion fares. Likewise, passengers could opt for 7 day excursion fare when they qualify for 14 day excursion fares. These two new environments were modeled in the second experiment and compared to the control environment and the maximum discount environment.

Simulation of maximum 7 day non-refundable fare use required the following modification to the lead time test routine:

```
LTT   GOON,1;
      ACTIVITY/8,,0,ASF4;
      ACTIVITY/9,,0.4981,ASF5;
      ACTIVITY/11,,0.3971,ASF7;
      ACTIVITY/12,,0.1048,ASF2;
```

With this routine, 7 day non-refundable fares are obtained by all passengers who qualify. Furthermore, all passengers who qualify for excursion fares but who have between 2 and 7 day lead times obtain the 2 day excursion fares.

Simulation of the maximum use of 2 day excursion fares required the following modification to the lead time test routine:

```
LTT    GOON,1;
       ACTIVITY/8,,0,ASF4;
       ACTIVITY/9,,0,ASF5;
       ACTIVITY/11,,0.8952,ASF7;
       ACTIVITY/12,,0.1048,ASF2;
```

This modification results in all passengers who qualify for excursion fares obtaining 2 day excursion fares.

The results of this experiment are presented in Table VI. An analysis of variance and multiple comparison of means were used to determine which environments resulted in statistically significant differences in means. Scheffe's "S" method for multiple comparison was used as it is the most conservative of the commonly used multiple comparison methods (13:459). The SAS System for Elementary Statistical Analysis was used to conduct the ANOVA and Scheffe comparison. The SAS code and output are at Appendix F.

Table VI: Summary of Mixed Fare Experiment

Environment	Fare(s) Used	Mean Tot Cost ($M)	Std Dev($)
1	normal	27.05	30,000
2	max discount	27.09	26,540
3	max 7 day	26.63	30,060
4	max 2 day	26.98	25,000

The results of the multiple comparison show that all of the differences between means are statistically significant. Maximum use of 7 day non-refundable fares results in the greatest savings, followed by maximum use of 2 day excursion fares, no use of excursion fares, and maximum use of maximum discount fares.

The difference between the mean total costs for the lowest cost environment and the current (control) environment is estimated with the use of a confidence interval. Since this was a balanced test (both sample sizes were 20), the simplified formula for the confidence interval for the difference between means is appropriate (13:171).

$$(ybar1-ybar2)+-t_{a/2}s_p(1/n1+1/n2)^{1/2} \qquad (3)$$

where s_p is the pooled standard deviation for the two samples, n1 and n2 are the sample sizes, and ybar1 and ybar2 are the sample means. Using this equation we are 95 percent certain that the maximum use of 7 day excursion fares would yield a net annual savings of between $560,808 and $599,192.

Summary

The analyses of results presented in this chapter result in answers to the first two research questions presented in Chapter I. The first of these questions concerned how often travelers from WPAFB used and were eligible for promotional fares. The extent of use was determined from the travel records survey. This survey

showed that excursion fares are used in approximately 1.2 percent of all trips. The percentage of travelers who are eligible for excursion fares is much higher, and varies depending on the type of fare. The second research question concerned which mix of fare types would be likely to result in the greatest savings. The answer to this question was determined through simulation. Maximum use of 7 day non-refundable excursion fares resulted in the largest savings. The next chapter addresses these results further and answers the third research question.

IV. Conclusions and Recommendations

Introduction

The primary objectives of this research were to determine if the government was using promotional fares judiciously and to define and assess alternative policies regarding promotional fare use which would be likely to result in an overall cost savings. This chapter discusses the findings of this research and interprets the potential value of these findings in terms of practical application. Additionally, a discussion of the limitations of this research and suggestions for further research are presented. Finally, the conclusions, limitations, and recommendations are summarized.

Conclusions

The thrust of this research was to determine what guidance, if any, could be given to help travelers and orders approving authorities to determine whether excursion fares should be used. To define such guidance, surveys and experiments were conducted to determine present travel tendencies and the probable results of alternative policies.

A first step in determining whether a more judicious use of promotional fares is possible is to assess the current state of promotional fare use and knowledge. Since the burden of deciding whether to use a promotional fare rests largely on the traveler and orders approving

authority, it is reasonable to assume that widespread knowledge of the potential to use promotional fares is a prerequisite to their use. The responses to the questionnaire suggest that this knowledge is not widespread among travelers. Only 30.7 percent of respondents knew that promotional fares can be used for official government travel. Although we have not specifically surveyed orders approving authorities, it is unlikely that they have full knowledge of the application of discount fares. Furthermore, since no clear direction on promotional fare usage has been given, there is no reason to believe that the few travelers who know about these fares are equipped to use them effectively. This conclusion is reinforced by the fact that only 1.2 percent of the fares in the travel record survey were excursion fares.

The first experiment that was conducted was aimed at determining which types of promotional fares would contribute to net savings to the government. The major excursion fare types were identified as: 14 day non-refundable fares, 7 day non-refundable fares, 7 day 25 percent penalty fares, and 2 day 25 percent penalty fares. This experiment showed clearly that indiscriminate use of excursion fares would lead to an increase in overall travel costs. Furthermore this experiment showed that maximum use of 14 day non-refundable fares would result in penalties which would be greater than purchase savings. Although

these 14 day fares are generally the lowest round-trip fares available, the uncertainty associated with a 14 day lead time is great enough that penalties would overwhelm savings. On the other hand, significant net savings could be achieved by using the other three fare types. The increase in certainty associated with these shorter lead times results in lower net costs. With these lead times and fares, the ticket purchase savings become greater than the cancellation and change penalties.

Another experiment was conducted which showed that the lowest cost strategy was maximum use of seven day non-refundable fares with use of two day excursion fares for lead times of less than seven days. These results suggest that a traveler who has at least a seven day lead time should opt for the seven day non-refundable fare, and a passenger with a lead time between two and seven days should seek a two day excursion fare. These fare types are the best options available for travelers with these lead times and could result in annual savings of between $560,000 and $599,000. It is important to note that these figures are not guaranteed savings. Rather, they should be thought of as an upper bound of savings that could only be achieved if all eligible passengers were able to obtain these types of fares with schedules consistent with mission requirements. If the fares are capacity controlled, and they are all sold, the traveler would resort to a normal or status fare.

Alternatively, if the fare is only offered on one airline, and that airline travels at the wrong time, the passenger would use a normal or status fare. It is logical, however, that the portion of the projected savings that would be achieved would be roughly equal to the portion of the eligible travelers who obtained these promotional fares.

The findings presented represent a naive application of a policy. The findings regarding which promotional fares are cost effective are valid only in the context of an overall policy which mandates their use consistently. This does not mean that individual cases should be determined solely by this criteria. If a particular traveler is extraordinarily certain of his travel requirements 14 days ahead of time, then a 14 day non-refundable fare may be warranted. Conversely, if a traveler's plans are extraordinarily uncertain, the use of a 7 or 2 day excursion fare may be ill-advised. However, if we have no particular insight into whether a traveler or group of travelers have an unusual degree of certainty, adherence to a policy of this type makes sense.

Research Limitations

The limitations of this research fall into two basic categories: those limitations which tend to decrease the accuracy of the simulation results, and those which limit the scope of travel for which these findings apply.

The limitations which tend to compromise the accuracy of the simulation are that opinions were used to estimate important parameters, no investigation of the availability of capacity controlled fares was accomplished, and many key travel characteristics were treated as independent. Opinions were averaged to estimate lead time distributions and penalty projections because this was the simplest means of estimating these parameters within time constraints. It is possible that survey respondents don't know with reasonable accuracy what their lead times are and how often they would change their travel plans. Although errors in their estimates could tend to cancel each other out, it is conceivable that respondents consistently overestimated or underestimated some of the key parameters. Additionally, when more than one fare was published with the same eligibility rules, it was assumed that these fares would be used equally, and they were averaged. It is possible that these fares would be available and meet mission requirements at dramatically different rates. Therefore, weighted averages or additional model routines based on such rates would be more appropriate. Furthermore, important parameters such as route, stay length, lead time, and cancellation rates were treated as independent in the simulation. This simplifying assumption was necessary to produce a manageable model. Howev -, independence of these parameters is not necessarily real. tic. For example, there

may be routes which are traveled to by a specific subset of the base population. This subset may exhibit radically different lead times or certainty of travel requirements. If these routes have extraordinary penalty fees or fares, the overall costs could be skewed by these combined tendencies. Many other combinations of dependent tendencies are possible.

Other limitations of the research involve the scope of travel for which the findings apply. These include the fact that the fares and travel characteristics were compiled for travel from WPAFB only, no international travel was included, and that the simulation represented a "snapshot" in time. Since WPAFB represents only a small fraction of federal government activity, there is a potential that huge savings could be obtained by improving overall policies regarding promotional fare use. However, the findings of this research may not be valid for travel from other installations. Travel characteristics and fare and penalty structures could vary enough from installation to installation that completely different results would be obtained by modeling other installations. Additionally, there may be different strategies which would be effective for international travel. Finally, all fares, penalties and travel characteristics were collected during one year. These parameters are very dynamic, and it is possible that they will move in directions which will eventually

invalidate the findings that were valid at the time of the research.

Recommendations for Further Study

More research can be done to generalize these findings to other installations or to find alternative strategies for other installations. The development of similar models for other government installations would allow the investigation of policies for these installations. If trends arose an overall government policy could be formulated. The potential cost saving to the government is immense. Additionally, any models developed (including the one developed here) should be periodically updated to keep pace with changing airfares and travel characteristics.

The model developed here could be strengthened by investigating the portions of the time that different fares are available at times consistent with mission requirements. Adding this data to the model would allow for more accurate projections of savings rather than the upper bounds to savings that were projected here. An additional improvement to the model could be made if some of the subjectivity regarding estimates of lead times and trip changes was eliminated. Rather than administering an opinion poll as was done here, most of the subjectivity would be eliminated if a survey was done in which actual lead times and cancellation rates were collected over time. Additional work which examines specific organizations and determines

optimal policies based on the travel characteristics of each organization could yield other findings regarding the best use of promotional fares by each organization. Sensitivity analysis could also be conducted to determine the values of key parameters for which each finding is valid.

Summary

In summary, it is highly likely that the government could save a significant amount of money by instituting a more specific policy regarding the use of promotional fares by WPAFB employees. Indiscriminate use of promotional fares is likely to result in more penalties than it generates in ticket savings, but consistent use of certain groups of fares is likely to generate net savings. More research is required to develop optimal policies for each organization, but some results of this research would be helpful in the interim. Rules-of-thumb developed here are as follows: 14 day non-refundable excursion fares should not be used. Seven day non-refundable fares, 7 day 25 percent penalty fares, and 2 day excursion fares should be used when they are available. If a traveler is faced with a choice, between a 7 day non-refundable fare and a 7 day 25 percent penalty fare, the 7 day non-refundable fare is likely to be the better value.

These findings are only guidelines and should be deviated from on an exception basis. If a traveler has extraordinary certainty about his travel requirements, he

may be wise to purchase the cheaper 14 day excursion fare than any of the fares suggested here. Likewise, if he is unusually uncertain about his travel requirements he may be wise to forego all excursion fares and use the completely refundable regular or status fares.

In summary, this research has provided evidence that there are policies associated with government use of excursion fares which could generate significant savings. Such policies must take varying travel characteristics, fares, and penalties into account and allow for discretion on the part of the travelers and orders approving authorities. The results of this research apply to WPAFB employees only; however, the methodology developed herein could be used to evaluate alternative policies for other government installations.

Appendix A: Commercial Air Travel Questionnaire

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO ATTN OF: LS (Capt Barker, AV 785-6335)

SUBJECT: Commercial Air Travel Survey

TO: Survey Participant

1. You have been selected to participate in an Air Force Institute of Technology research project. Your participation in this project is strictly voluntary. Please take the time to complete the attached questionnaire and mail to:

Capt James Barker
AFIT/LSG
WPAFB OH 45433-6583

2. Your responses to the items in this questionnaire will be combined with information obtained from other sources to determine if cost savings can be achieved by changing government air travel policies. We guarantee complete confidentiality, and no attempt will be made to identify any individual with specific survey responses.

3. This survey has been approved and has been assigned USAF Survey Control Number 89-40. Your participation is sincerely appreciated.

John Dumond

JOHN DUMOND, LtCol, USAF
Head, Department of System
Acquisition Management
School of Systems and Logistics

1 Atch
Questionnaire

STRENGTH THROUGH KNOWLEDGE

COMMERCIAL AIR TRAVEL QUESTIONNAIRE PART I

USAF SCN 89-40

Please answer the following questions:

1. What organization do you work for? (check one)

   ____ ASD
   ____ HQ AFLC
   ____ AFWAL
   ____ FTD
   ____ 2750th
   ____ Other (please specify)____________

2. Please estimate the number of times per year that you take an official trip which includes the use of commercial air travel.

   _____trips per year

   If you answered "0 trips per year", you are finished with this questionnaire.

3. Are you aware that the government uses negotiated discount fares for much of its commercial air travel? (circle one)

   yes no

4. Are you aware that promotional fares are often available to the general public which are lower than the negotiated government fares? (circle one)

   yes no

5. Are you aware that it is possible for a government traveller to use promotional fares instead of government negotiated fares? (circle one)

   yes no

6. Have you ever used promotional fares instead of negotiated government fares? (circle one)

   yes no don't know

   If you answered "don't know", skip question 7.

7. Please estimate the percent of the time that you use promotional fares for your official government travel.

   ____ percent

COMMERCIAL AIR TRAVEL
QUESTIONNAIRE PART II

Most commercial air carriers offer promotional airfares to travelers who meet certain eligibility requirements such as advance purchase requirements. These promotional fares are often lower than government negotiated fares; however, significant cancellation and change penalties are often associated with these fares. If government travelers increased their use of promotional fares, the government would save money on many airline tickets but would lose money for cancellations and changes. The following questions are aimed at determining the extent to which promotional fares can be used by government employees and the frequency with which penalties would be assessed if promotional fares were used more often. Since many of these questions require you to make estimates based on previous travel, you are encouraged to review your travel records while answering these questions. Even if you do not have travel records, please answer these questions to the best of your ability.

1. Please estimate the percentages of your trips for which you know your air travel requirements (destination, dates, and approximate time of day for departure and return) the indicated amounts of time prior to travel.

    ____ percent of the time, I learn of my travel requirements 0-2 days prior to departure.

    ____ percent of the time, I learn of my travel requirements 2-3 days prior to departure.

    ____ percent of the time, I learn of my travel requirements 3-7 days prior to departure.

    ____ percent of the time, I learn of my travel requirements 7-14 days prior to departure.

    ____ percent of the time, I learn of my travel requirements 14-21 days prior to departure.

    ____ percent of the time, I learn of my travel requirements more than 21 days prior to departure.

The following questions are designed to determine the frequencies with which cancellation and change penalties would be assessed if the use of promotional fares was increased. In answering these questions, assume that flight reservations would be made as soon as you learn of your travel requirements.

2. Please estimate the percentage of the time that you would change or cancel your reservations if you made them <u>at least 21</u> days prior to departure.

____ percent of the time, I would change the time of my outbound flight.

____ percent of the time, I would change the time of my return flight.

____ percent of the time, I would cancel one or more of my flights.

3. Please estimate the percentage of the time that you would change or cancel your reservations if you made them <u>between 14 and 21</u> days prior to departure.

____ percent of the time, I would change the time of my outbound flight.

____ percent of the time, I would change the time of my return flight.

____ percent of the time, I would cancel one or more of my flights.

4 Please estimate the percentage of the time that you would change or cancel your reservations if you made them <u>between 7 and 14</u> days prior to departure.

____ percent of the time, I would change the time of my outbound flight.

____ percent of the time, I would change the time of my return flight.

____ percent of the time, I would cancel one or more of my flights.

5. Please estimate the percentage of the time that you would change or cancel your reservations if you made them between 3 and 7 days prior to departure.

____ percent of the time, I would change the time of my outbound flight.

____ percent of the time, I would change the time of my return flight.

____ percent of the time, I would cancel one or more of my flights.

6. Please estimate the percentage of the time that you would change or cancel your reservations if you made them between 2 and 3 days prior to departure.

____ percent of the time, I would change the time of my outbound flight.

____ percent of the time, I would change the time of my return flight.

____ percent of the time, I would cancel one or more of my flights.

Appendix B: List of Fares and Fare Averages

ROUTE	OW	RT	F14	F7X	CH7X	F7P	CHC7	F2	CHC2
DCA	140	280	198	198	75	238	59.5	280	0
			208			248	62	196	0
			218			258	64.5		
	140	280	208	198	75	248	62	217	0
LAX	169	338	318	248	75	308	77	388	97
			338			388	97		
			248			398	99.5		
						378	94.5		
						418	105		
	169	338	301	248	75	378	96	388	97
SAT	167	334	258	248	75	298	74.5	334	0
	204	408	248			318	79.5	408	0
			268						
	186	371	258	248	75	308	77	371	0
DFW	186	372	238	238	75	288	72	372	0
	169	338	258			278	69.5		
						308	77		
	178	355	248	238	75	291	73	372	0
STL	103	206	188	188	75	228	57	339	0
	236	472							
	170	339	188	188	75	228	57	339	0
SLC	229	458	294	294	75	358	89.5	458	0
			278			354	88.5		
			298			338	84.5		
			318						
	229	458	297	294	75	350	87.5	458	0
SEA	260	520	318	418	75	478	120	568	0
	308	616	418			378	94.5		
	284	568	368	418	75	428	107	568	0

VPS	273	546	218	264	75	314	78.5	546	0
			258		75	304	76		
			268						
	273	546	248	264	75	309	77	546	0
SAN	165	330	318	358	75	418	105	378	0
	213	426	358			378	95		
			378			408	102		
						438	110		
	189	378	351	358	75	411	103	378	0
DEN	158	316	258	258	75	298	74.5	353	0
	195	390	278			308	77		
						328	82		
	177	353	268	258	75	311	78	353	0
ATL	152	306	188	188	75	228	57	337	0
	184	368	198			238	59.5		
			228			248	62		
			238			268	67		
	169	337	213	188	75	246	62	337	0
OKC	175	350	238	278	75	278	69.5	382	0
	207	414	278			328	82		
			298						
	191	382	271	278	75	303	76	382	0
SMF	270	550	318	388	75	488	122	540	0
			388			448	112.		
			448						
	270	540	385	388	75	468	117	540	0
SFO	252	504	248	248	75	308	77	428	107
	298	596	358			398	99.5		
			338			408	102		
			378			418	105		
	275	550	331	248	75	383	96	428	107

MCO	246	492	238	238	75	248	62	278	69.5
	256	512	258	258	75	288	72	288	72
			278	278	75	308	77	298	74.5
						328	82	308	77
								318	79.5
	251	502	258	258	75	293	73	298	75
PBI	183	366	218	218	75	308	77	258	64.5
	173	346	238	238	75	268	67	318	79.5
			258	258	75	328	82	298	74.5
			278	278	75	288	72	328	82
				298	75			348	87
	178	356	248	258	75	298	75	310	78
ONT	170	340	318	338	75	378	94.5	371	0
	201	402	338			388	97		
			358			398	99.5		
						408	102		
						418	105		
	186	371	338	338	75	398	100	371	0
LGA	135	270	178	178	75	218	54.5	353	0
	218	436	198			238	59.5		
	177	353	188	178	75	228	57	353	0
SYR	222	444	208	208	75	248	62	444	0
			198						
	222	444	203	208	75	248	62	444	0
ABQ	186	372	284	345	86	334	83.5	400	0
	187	374	278			338	84.5		
	227	454	304			344	86		
						364	91		
	200	400	290	345	86	345	86	400	0
BDL	177	354	198	198	75	248	62	354	0
			218			268	67		
			238						
	177	354	218	198	75	258	65	354	0

ORD	68	136	158	158	75	178	44.5	137	0
	69	138	178			198	49.5		
			228			278	69.5		
						218	54.5		
	69	137	188	158	75	218	55	137	0
PHX	179	358	298	436	109	358	89.5	458	115
	197	394	338			388	97	478	120
			358			498	125		
			418			478	120		
			398			458	115		
	188	376	362	436	109	436	109	468	117
TPA	267	534	238	238	75	288	72	278	69.5
	277	554	258	258	75	308	77	338	85
	317	634	278	278	75	328	82	298	74.5
			298	298	75			318	79.5
								328	82
	287	574	268	269	75	308	77	312	78
BOS	183	366	218	218	75	258	65	391	0
	208	416	238			268	67		
						278	69.5		
						288	72		
	196	391	228	218	75	273	68.3	391	0
BWI	140	280	198	198	75	238	59.5	280	0
			205			248	62		
			208			258	64.5		
			218						
			238						
	140	280	213	198	75	248	62	280	0
HSV	248	496	198	258	75	298	74.5	496	0
			258						
	248	496	228	258	75	298	75	496	0
LGB	162	324	318	396	99	398	99.5	372	0
	163	326	338			378	94.5		
	209	418	358			388	97		
	210	420				418	105		
	186	372	338	396	99	396	99	372	0

OMA	180	360	248	248	75	258	64.5	360	0
			218			288	72		
	180	360	233	248	75	273	68	360	0
PHL	124	248	178	178	75	218	54.5	249	0
	125	250	198			238	59.5		
	125	249	188	178	75	228	57	249	0
LAS	162	324	299	428	75	498	125	371	0
	209	418	388	388	75	488	122		
			428			508	127		
			338			358	89.5		
			448			478	120		
	186	371	380	308	75	466	117	371	0
MCN	209	418	188	228	57	228	57	418	0
			198						
	209	418	193	228	57	228	57	418	0
MGM	220	440	208	208	75	248	62	440	0
			218			268	67		
			228						
	220	440	218	208	75	258	64.5	440	0
MSP	148	296	158	178	75	218	54.5	371	0
	223	446	178			238	59.5		
			198						
	186	371	188	178	75	228	57	371	0
TUS	199	398	298	452	113	388	97	444	0
	222	444	338			478	120		
	254	488	358			488	122		
			448			508	127		
			468			398	99/5		
	222	444	382	452	113	452	113	444	0
PHF	130	260	188	228	57	228	57	260	0
COS	158	316	258	316	79	298	75	341	0
	159	318	278			308	77		
	195	390				318	79.5		
						338	84.5		
	171	341	268	316	79	316	79	341	0

SJC	252	504	338	422	106	378	94.5	550	0
	298	596	358			398	99.5		
			368			418	105		
			378			478	120		
						438	110		
	275	550	361	422	106	422	106	550	0
PIT	114	228	137	137	75	171	42.8	290	0
	176	352	157			191	47.8		
	145	290	147	137	75	181	45	290	0
JFK	135	270	178	178	75	228	57	353	0
	218	436	198						
	177	353	188	178	75	228	57	353	0
ROA	142	284	148	225	56	188	47	375	0
	150	300	168			208	52		
	200	400	238			278	69.5		
	257	514							
	187	375	185	225	56	225	56	375	0
SNA	162	324	318	368	75	528	107	371	0
	209	418	358			378	94.5		
			368			418	105		
			438			498	125		
						478	120		
	186	371	371	368	75	440	110	371	0
CLT	163	326	108	128	32	128	32	326	0
BUF	145	290	174	174	75	214	54	326	0
DTW	196	392	148	148	75	196	49	347	0
	159	318	156			208	52		
	149	298	168						
	189	378	188						
	173	347	165	148	75	202	51	347	0

Appendix C: SLAM Model Code

```
GEN,JBARKER,WASH,2/16/88,20;
LIMITS,1,10,100;
;              OW   RT F14 F7X CH7 F7  CC7 F2  CC2
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ARRAY(12,9)/191,382,271,278, 75,303, 76,382,  0; OKC
ARRAY(13,9)/270,540,385,388, 75,468,117,540,  0; SMF
ARRAY(14,9)/275,550,331,248, 75,383, 96,428,107; SFO
ARRAY(15,9)/251,502,258,258  75,293, 73,298, 75; MCO
ARRAY(16,9)/178,356,248,258, 75,298, 75,310, 78; PBI
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ARRAY(18,9)/177,353,188,178, 75,228, 57,353,  0; LGA
ARRAY(19,9)/222,444,203,208, 75,248, 62,440,  0; SYR
ARRAY(20,9)/200,400,289,345, 86,345, 86,400,  0; ABQ
ARRAY(21,9)/177,354,218,198, 75,258, 65,354,  0; BDL
ARRAY(22,9)/ 69,138,188,158, 75,218, 55,138,  0; ORD
ARRAY(23,9)/188,376,362,436,109,436,109,468,117; PHX
ARRAY(24,9)/241,482,235,248, 75,273, 68,482,  0; ICT
ARRAY(25,9)/287,574,268,268, 75,308, 77,312, 78; TPA
ARRAY(26,9)/196,391,228,218, 75,263, 66,392,  0; BOS
ARRAY(27,9)/140,280,213,198, 75,248, 62,280,  0; BWI
ARRAY(28,9)/248,496,228,258, 75,298, 75,496,  0; HSV
ARRAY(29,9)/186,371,338,396, 99,396, 99,371,  0; LGB
ARRAY(30,9)/206,413,188,178, 75,228, 57,413,  0; EWR
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ARRAY(33,9)/186,371,380,308, 75,466,117,371,  0; LAS
ARRAY(34,9)/209,418,193,228, 57,228, 57,418,  0; MCN
ARRAY(35,9)/220,440,218,208, 75,258, 65,440,  0; MGM
ARRAY(36,9)/186,371,188,178, 75,228, 57,371,  0; MSP
ARRAY(37,9)/222,443,382,452,113,452,113,443,  0; TUS
ARRAY(38,9)/108,217,208,198, 75,248, 62,217,  0; IAD
ARRAY(39,9)/130,260,188,228, 57,228, 5[illegible],260,  0; PHF
ARRAY(40,9)/171,341,268,316, 79,316, 79-341,  0; COS
ARRAY(41,9)/275,550,361,422,106,422,106,550,  0; SJC
ARRAY(42,9)/145,290,147,137, 75,181, 45,290,  0; PIT
ARRAY(43,9)/177,353,188,178, 75,228, 57,353,  0; JFK
ARRAY(44,9)/187,374,185,225, 56,225, 56,374,  0; ROA
ARRAY(45,9)/[illegible]6,372,371,368, 75,440,110,372,  0; SNA
ARRAY(46,9)/[illegible]63,326,108,128, 32,128, 32,326,  0; CLT
ARRAY(47,9)/145,290,174,174, 75,214, 54,290,  0; BUF
```

```
ARRAY(48,9)/173,347,165,148, 75,202, 51,347,  0; DTW
;
;      ATRIB(1)=ROUTE
;      ATRIB(6)=CHANGE PENALTY
;      ATRIB(7)=FARE
;      ATRIB(8)=CANCEL PENALTY
;      XX(1)=SUM OF FARES FOR RUN
;      XX(2)=PASSENGER NUMBER FOR RUN
;      XX(3)=AVG FARE FOR RUN
;
NETWORK;
       CREATE,1,,,74000,1;
       ASSIGN,XX(2)=XX(2)+1;      ASSIGN PASSENGER NUMBER
;
;      ASSIGN ROUTE
;
       GOON,1;
       ACTIVITY,,0.1507,DCA;
       ACTIVITY,,0.1297,LAX;
       ACTIVITY,,0.0778,SAT;
       ACTIVITY,,0.0681,DFW;
       ACTIVITY,,0.0454,STL;
       ACTIVITY,,0.0438,SLC;
       ACTIVITY,,0.0292,SEA;
       ACTIVITY,,0.0276,VPS;
       ACTIVITY,,0.0276,SAN;
       ACTIVITY,,0.0227,DEN;
       ACTIVITY,,0.0211,ATL;
       ACTIVITY,,0.0211,OKC;
       ACTIVITY,,0.0194,SMF;
       ACTIVITY,,0.0194,SFO;
       ACTIVITY,,0.0162,MCO;
       ACTIVITY,,0.0162,PBI;
       ACTIVITY,,0.0146,ONT;
       ACTIVITY,,0.0130,LGA;
       ACTIVITY,,0.0130,SYR;
       ACTIVITY,,0.0130,ABQ;
       ACTIVITY,,0.0130,BDL;
       ACTIVITY,,0.0113,ORD;
       ACTIVITY,,0.0113,PHX;
       ACTIVITY,,0.0113,ICT;
       ACTIVITY,,0.0113,TPA;
       ACTIVITY,,0.0113,BOS;
       ACTIVITY,,0.0097,BWI;
       ACTIVITY,,0.0097,HSV;
       ACTIVITY,,0.0097,LGB;
       ACTIVITY,,0.0081,EWR;
       ACTIVITY,,0.0081,OMA;
       ACTIVITY,,0.0081,PHL;
       ACTIVITY,,0.0081,LAS;
       ACTIVITY,,0.0065,MCN;
       ACTIVITY,,0.0065,MGM;
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```
        ACTIVITY,,0.0065,MSP;
        ACTIVITY,,0.0065,TUS;
        ACTIVITY,,0.0065,IAD;
        ACTIVITY,,0.0065,PHF;
        ACTIVITY,,0.0065,COS;
        ACTIVITY,,0.0065,SJC;
        ACTIVITY,,0.0049,PIT;
        ACTIVITY,,0.0049,JFK;
        ACTIVITY,,0.0049,ROA;
        ACTIVITY,,0.0032,SNA;
        ACTIVITY,,0.0032,CLT;
        ACTIVITY,,0.0032,BUF;
        ACTIVITY,,0.0031,DTW;
DCA     ASSIGN,ATRIB(1)=1;
        ACTIVITY,,,RTT;
LAX     ASSIGN,ATRIB(1)=2;
        ACTIVITY,,,RTT;
SAT     ASSIGN,ATRIB(1)=3;
        ACTIVITY,,,RTT;
DFW     ASSIGN,ATRIB(1)=4;
        ACTIVITY,,,RTT;
STL     ASSIGN,ATRIB(1)=5;
        ACTIVITY,,,RTT;
SLC     ASSIGN,ATRIB(1)=6;
        ACTIVITY,,,RTT;
SEA     ASSIGN,ATRIB(1)=7;
        ACTIVITY,,,RTT;
VPS     ASSIGN,ATRIB(1)=8;
        ACTIVITY,,,RTT;
SAN     ASSIGN,ATRIB(1)=9;
        ACTIVITY,,,RTT;
DEN     ASSIGN,ATRIB(1)=10;
        ACTIVITY,,,RTT;
ATL     ASSIGN,ATRIB(1)=11;
        ACTIVITY,,,RTT;
OKC     ASSIGN,ATRIB(1)=12;
        ACTIVITY,,,RTT;
SMF     ASSIGN,ATRIB(1)=13;
        ACTIVITY,,,RTT;
SFO     ASSIGN,ATRIB(1)=14;
        ACTIVITY,,,RTT;
MCO     ASSIGN,ATRIB(1)=15;
        ACTIVITY,,,RTT;
PBI     ASSIGN,ATRIB(1)=16;
        ACTIVITY,,,RTT;
ONT     ASSIGN,ATRIB(1)=17;
        ACTIVITY,,,RTT;
LGA     ASSIGN,ATRIB(1)=18;
        ACTIVITY,,,RTT;
SYR     ASSIGN,ATRIB(1)=19;
        ACTIVITY,,,RTT;
ABQ     ASSIGN,ATRIB(1)=20;
```

```
        ACTIVITY,,,RTT;
BDL     ASSIGN,ATRIB(1)=21;
        ACTIVITY,,,RTT;
ORD     ASSIGN,ATRIB(1)=22;
        ACTIVITY,,,RTT;
PHX     ASSIGN,ATRIB(1)=23;
        ACTIVITY,,,RTT;
ICT     ASSIGN,ATRIB(1)=24;
        ACTIVITY,,,RTT;
TPA     ASSIGN,ATRIB(1)=25;
        ACTIVITY,,,RTT;
BOS     ASSIGN,ATRIB(1)=26;
        ACTIVITY,,,RTT;
BWI     ASSIGN,ATRIB(1)=27;
        ACTIVITY,,,RTT;
HSV     ASSIGN,ATRIB(1)=28;
        ACTIVITY,,,RTT;
LGB     ASSIGN,ATRIB(1)=29;
        ACTIVITY,,,RTT;
EWR     ASSIGN,ATRIB(1)=30;
        ACTIVITY,,,RTT;
OMA     ASSIGN,ATRIB(1)=31;
        ACTIVITY,,,RTT;
PHL     ASSIGN,ATRIB(1)=32;
        ACTIVITY,,,RTT;
LAS     ASSIGN,ATRIB(1)=33;
        ACTIVITY,,,RTT;
MCN     ASSIGN,ATRIB(1)=34;
        ACTIVITY,,,RTT;
MGM     ASSIGN,ATRIB(1)=35;
        ACTIVITY,,,RTT;
MSP     ASSIGN,ATRIB(1)=36;
        ACTIVITY,,,RTT;
TUS     ASSIGN,ATRIB(1)=37;
        ACTIVITY,,,RTT;
IAD     ASSIGN,ATRIB(1)=38;
        ACTIVITY,,,RTT;
PHF     ASSIGN,ATRIB(1)=39;
        ACTIVITY,,,RTT;
COS     ASSIGN,ATRIB(1)=40;
        ACTIVITY,,,RTT;
SJC     ASSIGN,ATRIB(1)=41;
        ACTIVITY,,,RTT;
PIT     ASSIGN,ATRIB(1)=42;
        ACTIVITY,-,RTT;
JFK     ASSIGN,ATRIB(1)=43;
        ACTIVITY,,,RTT;
ROA     ASSIGN,ATRIB(1)=44;
        ACTIVITY,,,RTT;
SNA     ASSIGN,ATRIB(1)=45;
        ACTIVITY,,,RTT;
CLT     ASSIGN,ATRIB(1)=46;
```

```
        ACTIVITY,,,RTT;
BUF     ASSIGN,ATRIB(1)=47;
        ACTIVITY,,,RTT;
DTW     ASSIGN,ATRIB(1)=48;
        ACTIVITY,,,RTT;
;
;       TEST FOR ROUND TRIP
;
RTT     GOON,1;
        ACTIVITY/1,,0.954,SUNT;
        ACTIVITY/2,,0.046,ASF1;
;
;       ASSIGN ONE-WAY FARE
;
ASF1    ASSIGN,XX(1)=XX(1)+ARRAY(ATRIB(1),1);
        ACTIVITY,,,TERM;
;
;       TEST FOR SUNDAY STAY
;
SUNT    GOON,1;
        ACTIVITY/3,,0.179,SIXT;
        ACTIVITY/4,,0.821,ASF2;
;
;       ASSIGN NORMAL ROUND TRIP FARE
;
ASF2    ASSIGN,XX(1)=XX(1)+ARRAY(ATRIB(1),2);
        ACTIVITY,,,TERM;
;
;       TEST FOR 60 DAY STAY
;
SIXT    GOON,1;
        ACTIVITY/5,,0.997,LTT;
        ACTIVITY/6,,0.003,ASF2;
;
;       TEST FOR LEAD TIME
;
LTT     GOON,1;
        ACTIVITY/8,,0.2377,ASF4;
        ACTIVITY/9,,0.2604,ASF5;
        ACTIVITY/11,,0.3971,ASF7;
        ACTIVITY/12,,0.1048,ASF2;
;
;       14 DAY EXCURSION
;
ASF4    ASSIGN,ATRIB(7)=ARRAY(ATRIB(1),3),1;
        ASSIGN,ATRIB(8)=ARRAY(ATRIB(1),3),1;
        GOON,1;
        ACTIVITY/13,,0.557,ASC;
        ACTIVITY/14,,0.443,;
        ASSIGN,XX(1)=XX(1)+ATRIB(7);
        ACTIVITY,,,TERM;
;
```

```
;      7 DAY EXCURSION
;
ASF5   ASSIGN,ATRIB(7)=ARRAY(ATRIB(1),4),1;
       ASSIGN,ATRIB(8)=ARRAY(ATRIB(1),4),1;
       ASSIGN,ATRIB(6)=ARRAY(ATRIB(1),5),1;
       GOON,1;
       ACTIVITY/15,,0.117,ASC;
       ACTIVITY/16,,0.560,NOCH;
       ACTIVITY/17,,0.323,;
       ASSIGN,XX(1)=XX(1)+ATRIB(6);    NOCH
ASSIGN,XX(1)=XX(1)+ATRIB(7);
       ACTIVITY,,,TERM;
;
:      2 DAY EXCURSION
;
ASF7   ASSIGN,ATRIB(7)=ARRAY(ATRIB(1),8),1;
       ASSIGN,ATRIB(8)=ARRAY(ATRIB(1),9),1;
       GOON,1;
       ACTIVITY/18,,0.218,ASC;
       ACTIVITY/19,,0.782,;
       ASSIGN,XX(1)=XX(1)+ATRIB(7);
       ACTIVITY,,,TERM;
;
;      ASSIGN CANCELLATION FEE
;
ASC    ASSIGN,XX(1)=XX(1)+ATRIB(8);
       ACTIVITY,,,RTT;
TERM   GOON,1;
       ACTIVITY,,XX(2).LT.74000,NEXT;
       ACTIVITY,,XX(2).GE.74000;
;
;      CALCULATE AVERAGE FARE FOR RUN
;
       ASSIGN,XX(3)=XX(1)/74000;
;
;      COLLECT STATS FOR EACH RUN
;
       COLCT(1),XX(1),TOT COST,20/26640000/37000;
       COLCT(2),XX(3),AVG FARE,;
NEXT   TERMINATE;
       END NETWORK;
INIT,0,,N;
FIN;
```

Appendix D: Questionnaire Responses and Averages

PART 1

RESPONDENT	QUESTIONS 1	2	3	4	5	6	7
1	AFWAL	30	yes	yes	no	no	0
2	AFWAL	2	yes	no	no	no	0
3	AFWAL	40	yes	yes	yes	yes	3.5
4	AFWAL	12	yes	yes	yes	yes	8
5	AFWAL	15	yes	yes	yes	no	0
6	AFWAL	35	yes	yes	yes	no	0
7	AFWAL	28	yes	yes	yes	yes	1
8	AFWAL	17	yes	yes	no	d.k.	0
9	FTD	6	yes	yes	yes	no	0
10	FTD	25	yes	yes	no	d.k.	0
11	FTD	25	yes	yes	no	no	0
12	FTD	12	yes	yes	yes	no	0
13	FTD	12	yes	yes	yes	yes	0
14	FTD	50	yes	no	no	no	0
15	FTD	24	yes	no	yes	d.k.	0
16	FTD	18	yes	yes	yes	yes	10
17	FTD	7	yes	yes	no	no	0
18	FTD	15	yes	yes	yes	no	0
19	ASD	7	yes	yes	yes	yes	25
20	ASD	15	yes	yes	no	no	0
21	ASD	30	yes	yes	yes	d.k.	0
22	ASD	30	yes	yes	no	no	0
23	ASD	30	yes	yes	no	d.k.	0
24	ASD	16	yes	yes	yes	no	0
25	ASD	2	yes	yes	no	no	0
26	ASD	5	yes	no	no	no	0
27	ASD	18	yes	yes	no	no	0
28	ASD	20	yes	no	no	d.k.	0
29	ASD	15	yes	no	yes	no	0
30	ASD	10	yes	no	no	d.k.	0
31	ASD	8	yes	yes	no	d.k.	0
32	ASD	30	yes	yes	no	no	0
33	ASD	20	yes	no	no	no	0
34	ASD	25	yes	no	no	no	0
35	ASD	25	yes	yes	yes	no	0
36	ASD	18	yes	yes	yes	d.k.	0
37	ASD	8	yes	yes	yes	yes	10
38	ASD	18	yes	yes	no	d.k.	0
39	ASD	16	yes	yes	yes	yes	10
40	ASD	18	yes	yes	yes	yes	1
41	ASD	20	yes	no	no	d.k.	0
42	ASD	30	yes	yes	yes	yes	5
43	ASD	12	no	no	no	no	0
44	ASD	20	yes	yes	no	no	0
45	ASD	3	yes	yes	no	no	0
46	ASD	14	yes	yes	yes	yes	4

	QUESTIONS						
RESPONDENT	1	2	3	4	5	6	7
47	HQ AF	15	yes	no	no	no	0
48	HQ AF	18	yes	yes	no	no	0
49	HQ AF	10	yes	yes	yes	no	0
50	HQ AF	8	yes	no	no	d.k.	0
51	HQ AF	6	no	no	no	no	0
52	HQ AF	5	yes	no	no	d.k.	0
53	HQ AF	4	yes	no	no	d.k.	0
54	HQ AF	4	yes	yes	no	no	0
55	HQ AF	5	yes	yes	no	d.k.	0
56	HQ AF	8	yes	yes	no	no	0
57	IQ AF	15	yes	no	no	d.k.	0
58	HQ AF	15	yes	yes	no	d.k.	0
59	HQ AF	8	yes	yes	yes	no	0
60	HQ AF	3	no	no	no	d.k.	0
61	LOC	2	yes	yes	no	d.k.	0
62	LOC	4	no	yes	no	no	0
63	LOC	5	yes	yes	yes	yes	10
64	LOC	12	yes	yes	yes	d.k.	0
65	LOC	10	yes	yes	no	yes	5
66	ILC	25	yes	yes	no	d.k.	0
67	ILC	12	yes	yes	yes	no	0
68	ILC	20	yes	no	no	d.k.	0
69	OTHER	17	yes	no	no	no	0
70	OTHER	9	yes	no	no	no	0
71	OTHER	20	yes	yes	yes	yes	5
72	OTHER	20	yes	yes	no	no	0
73	OTHER	2	yes	no	no	no	0
74	OTHER	12	yes	yes	no	d.k.	0
75	OTHER	10	yes	yes	yes	yes	1
76	OTHER	20	yes	yes	no	no	0
77	OTHER	18	yes	yes	no	no	0
78	OTHER	20	yes	yes	no	d.k.	0
79	OTHER	4	yes	no	no	d.k.	0

PART II

	ORG.	1.a	1.b	1.c	1.d	1.e	1.f	2.a	2.b	2.c	3.a	3.b
		QUESTIONS										
1	AFWAL	10	10	40	20	20	10	90	90	60	90	90
2	AFWAL	0	0	5	5	10	80	0	0	0	0	0
3	AFWAL	5	10	50	25	5	5	25	25	10	20	20
4	AFWAL	8	0	32	60	0	0	8	32	16	8	32
5	AFWAL	6	12	39	25	12	6	10	20	5	10	20
6	AFWAL	20	0	40	20	15	5	10	20	10	10	0
7	AFWAL	18	63	15	4	0	0	40	85	95	40	85
8	AFWAL	0	1	5	39	35	20	45	45	10	40	40
9	FTD	2	5	10	35	30	18	10	10	18	10	10
10	FTD	15	30	40	15	0	0					
11	FTD	5	5	5	10	15	60	30	60	15	10	50
12	FTD	0	2	8	50	25	15	75	0	0	25	0
13	FTD	5	5	10	75	5	0	50	50	15	25	25
14	FTD	50	25	20	5	0	0	80	80	20	60	70
15	FTD	0	50	25	0	0	25	50	50	50	50	50
16	FTD	5	15	75	5	0	0	90	80	10	90	80
17	FTD	8	4	13	41	25	9	20	40	5	20	40
18	FTD	10	10	50	30	0	0	95	95	95	70	70
19	ASD	0	10	15	50	25	0	15	25	20	5	10
20	ASD	5	5	80	5	5	0	0	60	0	0	80
21	ASD	10	15	25	25	15	10	20	25	40	15	20
22	ASD	30	15	10	10	15	20	25	25	50	20	20
23	ASD	10	10	50	15	10	5	50	70	30	50	70
24	ASD	5	10	20	40	15	10	25	35	10	15	25
25	ASD	0	0	0	0	0	100	0	0	0	0	0
26	ASD	10	30	10	40	5	5	10	5	5	10	5
27	ASD	5	20	35	25	10	5	15	50	5	10	50
28	ASD	30	20	40	5	5	0				10	10
29	ASD	5	10	30	40	10	5	30	50	20	30	50
30	ASD	5	10	50	30	5	0	35	40	60	30	35
31	ASD	5	5	10	20	30	30	20	20	2	20	20
32	ASD	20	20	40	10	10	0	40	80	90	30	10
33	ASD	33	33	33	0	0	0	0	0	0	0	0
34	ASD	3	3	4	49	20	1	95	75	95	50	50
35	ASD	0	0	90	10	0	0	20	60	20	20	60
36	ASD	5	5	25	50	15	0	50	50	25	25	25
37	ASD	15	0	5	10	30	40	0	0	5	0	0
38	ASD	5	10	25	50	5	25	10	10	11	15	5
39	ASD	10	15	50	25	0	0	80	25	25	50	50
40	ASD	5	10	75	5	3	2	75	75	75	40	40
41	ASD	30	15	25	10	10	10	5	5	5	7	7
42	ASD	5	5	15	50	20	5	10	95	5	10	95
43	ASD	2	3	95	0	0	0	75	80	80	75	75
44	ASD	2	3	5	20	60	10	40	40	30	30	30
45	ASD	0	10	10	30	20	30	30	30	30	10	10
46	ASD	90	0	0	0	5	5	80	80	20	80	80

		QUESTIONS										
		1.a	1.b	1.c	1.d	1.e	1.f	2.a	2.b	2.c	3.a	3.b
47	HQ AF	0	0	100	0	0	0	90	30	30	80	30
48	HQ AF	0	0	5	5	10	80	0	0	50	0	1
49	HQ AF	5	5	10	40	30	10	20	70	10	20	70
50	HQ AF	10	15	20	35	15	5	20	30	25	10	30
51	HQ AF	90	5	5	0	0	0	10	10	10	10	10
52	HQ AF	0	0	0	100	0	0	1	2	0	0	1
53	HQ AF	0	0	100	0	0	0	50	50	10	75	75
54	HQ AF	1	1	1	91	5	1	50	50	50	10	10
55	HQ AF	0	0	10	70	10	10	2	2	2	1	1
56	HQ AF	1	1	35	35	23	5	10	30	10	5	20
57	HQ AF	10	20	0	70	0	0	100	100	0	80	80
58	HQ AF	5	15	40	30	10	0	30	30	50	30	30
59	HQ AF	0	50	25	0	25	0	0	0	25	0	0
60	HQ AF	0	0	0	0	25	75	5	5	5	5	5
61	LOC	80	10	5	5	0	0	50	80	80	50	80
62	LOC	1	85	11	3	0	0					
63	LOC	0	0	10	20	50	20	0	10	10	0	10
64	LOC	0	25	25	50	0	0	0	25	25	0	25
65	LOC	0	0	5	20	70	5	10	10	20	10	10
66	ILC	10	25	50	5	5	5	20	20	20	20	20
67	ILC	5	25	60	5	5	0	90	50	25	50	30
68	ILC	2	5	10	50	23	10	20	20	30	10	10
69	OTHER	0	0	20	20	40	20	30	20	10	10	20
70	OTHER	50	5	15	20	10	0	30	5	20	20	5
71	OTHER	25	25	25	20	5	0	100	100	50	50	50
72	OTHER	0	10	45	45	0	0	10	20	0	10	20
73	OTHER	0	0	5	10	10	75	0	10	10	0	10
74	OTHER	10	5	5	50	10	10	25	50	10	10	10
75	OTHER	5	5	10	65	15	5	10	10	10	10	10
76	OTHER	0	10	20	30	20	20	15	15	15	10	10
77	OTHER	0	25	25	50	0	0	0	0	0	0	0
78	OTHER	5	10	50	25	10	0	20	10	20	20	10
79	OTHER	0	1	99	0	0	0	0	0	0	0	0

		QUESTIONS									
		3.c	4.a	4.b	4.c	5.a	5.b	5.c	6.a	6.b	6.c
1	AFWAL	60	70	70	60	70	70	60	50	50	60
2	AFWAL	0	0	0	0	0	0	0	0	0	0
3	AFWAL	10	10	10	5	10	10	1	10	10	1
4	AFWAL	16	8	32	16	8	32	16	8	32	16
5	AFWAL	2	2	10	2	0	5	0	0	0	0
6	AFWAL	10	10	20	10	15	15	5	15	20	5
7	AFWAL	95	20	65	70	5	45	55	1	30	35
8	AFWAL	5	15	15	2	5	5	1	1	1	1
9	FTD	12.5	7.5	7.5	10	5	5	5	1	2	3
10	FTD					20	20	20	20	20	15
11	FTD	10	10	30	10	0	0	0	0	0	0
12	FTD	0	5	0	0	5	0	0	5	0	0
13	FTD	10	10	10	5	10	10	5	0	0	10
14	FTD	15	60	60	15	30	30	10	30	10	5
15	FTD	50	50	50	50	25	25	25	25	25	25
16	FTD	10	60	50	10	20	20	10	0	0	0
17	FTD	5	30	30	10	10	30	10	10	40	10
18	FTD	50	50	50	30	35	35	25	20	20	10
19	ASD	10	5	5	5	5	5	5	5	5	5
20	ASD	0	5	0	0	5	0	0	5	0	0
21	ASD	30	10	15	15	5	5	5	10	20	25
22	ASD	30	10	10	20	10	10	15	5	5	10
23	ASD	50	30	50	10	0	0	0	0	0	0
24	ASD	10	15	25	10	5	20	5	0	20	5
25	ASD	0	0	0	0	0	0	0	0	0	0
26	ASD	5	10	5	5	10	5	5	0	0	10
27	ASD	3	3	50	2	1	50	1	1	50	1
28	ASD	0	10	10	0	10	10	0	5	5	0
29	ASD	20	30	50	20	30	50	20	30	50	20
30	ASD	50	25	30	50	15	20	25	5	15	15
31	ASD	2	10	20	2	30	20	2	30	20	2
32	ASD	40	5	10	15	2	5	5	0	2	4
33	ASD	0	0	0	0	20	10	5	5	1	1
34	ASD	30	10	10	0	0	10	0	0	10	0
35	ASD	20	20	60	20	5	60	10	0	60	0
36	ASD	10	10	10	5	10	10	10	5	5	5
37	ASD	5	0	0	10	0	0	0	0	0	0
38	ASD	10	10	5	5	5	5	5	5	5	5
39	ASD	40	10	10	25	10	10	20	5	5	5
40	ASD	40	25	25	25	5	5	5	0	0	0
41	ASD	7	9	9	9	10	10	10	10	25	25
42	ASD	5	10	95	5	10	95	5	10	95	5
43	ASD	75	25	25	25	25	0	0	0	0	0
44	ASD	20	20	30	10	10	10	10	5	5	5

		3.c	4.a	4.b	4.c	5.a	5.b	5.c	6.a	6.b	6.c
		QUESTIONS									
45	ASD	10	5	5	5	1	1	1	0	0	0
46	ASD	20	20	20	5	1	1	1	1	1	1
47	HQ AF	30	50	30	30	30	30	30	30	30	30
48	HQ AF	50	0	0	50	0	0	10	0	0	0
49	HQ AF	10	20	70	10	20	70	10	20	70	10
50	HQ AF	25	5	30	15	5	15	10	10	10	10
51	HQ AF	10	0	0	5	0	0	5	0	0	0
52	HQ AF	0	0	1	0	0	1	0	0	0	0
53	HQ AF	20	20	20	5	10	10	2	5	5	1
54	HQ AF	10	1	1	1	0	0	0	0	0	0
55	HQ AF	1	0	0	0	0	0	0	0	0	0
56	HQ AF	5	4	10	4	1	5	2	1	5	1
57	HQ AF	0	50	50	0	25	25	0	10	10	0
58	HQ AF	50	10	10	20	5	5	10	5	5	10
59	HQ AF	25	5	5	10	0	0	5	0	0	0
60	HQ AF	5	0	0	0	0	0	0	0	0	0
61	LOC	80	20	20	20	10	10	10	10	10	10
62	LOC		5	25	25	2	10	5	0	10	0
63	LOC	10	0	0	10	0	0	0	0	0	0
64	LOC	25	0	25	25	0	25	0	0	25	0
65	LOC	20	2	2	5	0	0	2	0	0	2
66	ILC	20	10	10	10	5	5	5	5	5	5
67	ILC	10	25	10	10	15	5	5	5	1	1
68	ILC	20	5	5	10	0	0	0	0	0	0
69	OTHER	10	10	20	10	10	20	10	10	20	10
70	OTHER	10	15	5	10	10	20	20	5	10	10
71	OTHER	25	25	25	0	25	50	0	10	10	0
72	OTHER	0	0	0	0	5	10	0	5	5	10
73	OTHER	10	0	10	0	0	1	0	0	0	0
74	OTHER	10	10	10	10	5	5	5	5	5	5
75	OTHER	10	5	5	5	5	5	10	5	5	10
76	OTHER	10	5	5	5	2	2	2	1	1	1
77	OTHER	0	0	0	0	0	0	0	0	0	0
78	OTHER	20	0	10	10	0	0	0	0	0	0
79	OTHER	0	0	0	0	0	0	0	0	0	0

Appendix E: Excerpt from Sample SLAM Output Report

SIMULATION PROJECT WASH BY JBARKER

DATE 2/16/1988 RUN NUMBER 20 OF 20

CURRENT TIME .7400E+05
STATISTICAL ARRAYS CLEARED AT TIME .0000E+00

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBSERVATIONS
TOT COST	.2709E+08	.2654E+05	.9798E-03	.2703E+08	.2713E+08	20
AVG FARE	.3660E+03	.3586E+00	.9798E-03	.3653E+03	.3666E+03	20

FILE STATISTICS

FILE NUMBER	LABEL/TYPE	AVERAGE LENGTH	STANDARD DEVIATION	MAXIMUM LENGTH	CURRENT LENGTH	AVERAGE WAITING TIME
1		.0000	.0000	0	0	.0000
2	CALENDAR	1.0000	.0000	2	0	.1316

REGULAR ACTIVITY STATISTICS

ACTIVITY INDEX/LABEL	AVERAGE UTILIZATION	STANDARD DEVIATION	MAXIMUM UTIL	CURRENT UTIL	ENTITY COUNT
1	.0000	.0000	1	0	73605
2	.0000	.0000	1	0	3649
3	.0000	.0000	1	0	13205
4	.0000	.0000	1	0	60400
5	.0100	.0000	1	0	13186
6	.0000	.0000	1	0	19
8	.0001	.0000	1	0	3117
9	.0000	.0000	1	0	3467
11	.0000	.0000	1	0	5246
12	.0000	.0000	1	0	1356
13	.0000	.0000	1	0	1765
14	.0000	.0000	1	0	1352
15	.0000	.0000	1	0	378
16	.0000	.0000	1	0	2161
17	.0000	.0000	1	0	928
18	.0000	.0000	1	0	1111
19	.0000	.0000	1	0	4135

HISTOGRAM NUMBER 1

TOT COST

```
OBSV RELA CUML   UPPER
FREQ FREQ FREQ CELL LIMIT  0         20        40        60        80       100
                           +    +    +    +    +    +    +    +    +    +    +
  0  .000  .000 .2664E+08  +                                                 +
  0  .000  .000 .2668E+08  +                                                 +
  0  .000  .000 .2671E+08  +                                                 +
  0  .000  .000 .2675E+08  +                                                 +
  0  .000  .000 .2679E+08  +                                                 +
  0  .000  .000 .2683E+08  +                                                 +
  0  .000  .000 .2686E+08  +                                                 +
  0  .000  .000 .2690E+08  +                                                 +
  0  .000  .000 .2694E+08  +                                                 +
  0  .000  .000 .2697E+08  +                                                 +
  0  .000  .000 .2701E+08  +                                                 +
  2  .100  .100 .2705E+08  +*****                                            +
  5  .250  .350 .2708E+08  +*************    C                               +
 11  .550  .900 .2712E+08  +****************************                C    +
  2  .100 1.000 .2716E+08  +*****                                            C
  0  .000 1.000 .2720E+08  +                                                 C
  0  .000 1.000 .2723E+08  +                                                 C
  0  .000 1.000 .2727E+08  +                                                 C
  0  .000 1.000 .2731E+08  +                                                 C
  0  .000 1.000 .2734E+08  +                                                 C
  0  .000 1.000 .2738E+08  +                                                 C
  0  .000 1.000 INF        +                                                 C
---                        +    +    +    +    +    +    +    +    +    +    +
 20                        0         20        40        60        80       100
```

STATISTICS FOR VARIABLES BASED ON OBSERVATION

	MEAN VALUE	STANDARD DEVIATION	COEFF. OF VARIATION	MINIMUM VALUE	MAXIMUM VALUE	NUMBER OF OBSERVATIONS
TOT COST	.2709E+08	.2654E+05	.9798E-03	.2703E+08	.2713E+08	20

Appendix F: SAS ANOVA and Scheffe Comparison

```
options linesize=78;
data totcost;
 input totcost environ @@;
 cards;
27.06 1 27.07 1 27.00 1 27.03 1 27.07 1 27.08 1 27.04 1
27.03 1 27.07 1 27.04 1 27.07 1 27.07 1 27.02 1 26.98 1
27.01 1 27.08 1 27.03 1 27.06 1 27.05 1 27.10 1
27.12 2 27.04 2 27.10 2 27.08 2 27.09 2 27.03 2 27.10 2
27.06 2 27.13 2 27.11 2 27.09 2 27.06 2 27.07 2 27.07 2
27.10 2 27.09 2 27.08 2 27.09 2 27.13 2 27.10 2
26.65 3 26.65 3 26.63 3 26.62 3 26.68 3 26.57 3 26.66 3
26.67 3 26.64 3 26.60 3 26.59 3 26.63 3 26.61 3 26.62 3
26.67 3 26.60 3 26.63 3 26.68 3 26.65 3 26.62 3
27.02 4 26.99 4 26.96 4 26.98 4 27.00 4 26.96 4 26.97 4
27.01 4 26.99 4 26.98 4 26.95 4 26.93 4 26.95 4 26.96 4
27.02 4 26.96 4 26.98 4 26.97 4 26.97 4 26.95 4
;
proc anova;
 class environ;
 model totcost = environ;
 means environ / SCHEFFE;
```

```
                SAS       17:50 TUESDAY, AUGUST 1, 1989  1

                     ANALYSIS OF VARIANCE PROCEDURE

                         CLASS LEVEL INFORMATION

                         CLASS     LEVELS    VALUES

                         ENVIRON      4      1 2 3 4

                   NUMBER OF OBSERVATIONS IN DATA SET = 80
```

SAS 17:50 TUESDAY, AUGUST 1, 1989 2

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: TOTCOST

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE
MODEL	3	2.56744375	0.85581458	1075.16
ERROR	76	0.06049500	0.00079599	PR > F
CORRECTED TOTAL	79	2.62793875		0.0

R-SQUARE	C.V.	ROOT MSE	TOTCOST MEAN
0.976980	0.1047	0.02821324	26.93587500

SOURCE	DF	ANOVA SS	F VALUE	PR > F
ENVIRON	3	2.56744375	1075.16	0.0

SAS 17:50 TUESDAY, AUGUST 1, 1989 3

ANALYSIS OF VARIANCE PROCEDURE

SCHEFFE'S TEST FOR VARIABLE: TOTCOST
NOTE: THIS TEST CONTROLS THE TYPE I EXPERIMENTWISE ERROR RATE BUT GENERALLY HAS A HIGHER TYPE II ERROR RATE THAN REGWF FOR ALL PAIRWISE COMPARISONS

ALPHA=0.05 DF=76 MSE=8.0E-04
CRITICAL VALUE OF F=2.72494
MINIMUM SIGNIFICANT DIFFERENCE=.02551

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

SCHEFFE GROUPING	MEAN	N	ENVIRON
A	27.087000	20	2
B	27.048000	20	1
C	26.975000	20	4
D	26.633500	20	3

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This research assesses several possible policies aimed at decreasing government expenditures on commercial air travel from WPAFB. The policies which are evaluated are policies regarding the use of the promotional fares commonly offered by the large commercial air carriers. These promotional fares are generally lower than the fares presently used by government travelers, but there are significant penalties associated with itinerary changes after ticket purchase.

Computer simulation was used to evaluate these policies. A survey of travel records and a questionnaire administered to a random sample of WPAFB travelers were used to gather information regarding key travel characteristics of base personnel. This data was used as input to the simulation model. Total annual cost, including airfares and penalties, was used as a measure of performance, and separate experiments were run for each policy evaluated.

The results point to cost savings for some of the policies and losses for others. Recommendations for management action and further study are presented.